Essays on the Microeconomics of Development in the Middle East and North Africa

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Dedication

This thesis is dedicated to Jason R. Lord, who was with me every step of the way.

Abstract

This dissertation explores a variety of issues in the microeconomics of development, specifically in terms of labor and human development in the Middle East and North Africa. The three essays in this dissertation address a diverse array of development challenges through microeconomic and microeconometric analysis. The first essay investigates the returns to vocational secondary schooling as compared to other routes to vocational skills, such as apprenticeships, in Egypt. A longitudinal dataset allows for causal inference about returns by comparing siblings. The essay shows that, for recent cohorts, the estimated returns to vocational secondary education are the same as attaining no formal education, while the returns to skills obtained outside of formal education are substantial. The second essay first demonstrates that fertility has recently risen in Egypt and then investigates whether declining employment opportunities for women, and therefore lower opportunity costs for childrearing, may have contributed to the increase in fertility. Discrete-time hazard models are used to estimate the relationship between employment and childbearing, variously incorporating instrumental variables and fixed effects to address the endogeneity of employment. Results suggest that declining public sector employment, which is particularly appealing to women, contributed to the rise in fertility. The third essay identifies large socio-economic disparities in child health and nutrition in Jordan and investigates the factors contributing to inequality in children's height and weight, including parental health knowledge, food quantity and quality, health conditions, the health environment, and prenatal development. This essay demonstrates that the health environment and feeding contribute to inequality in child health but that these effects mediate only a small part of socio-economic disparities. Much of the inequality in children's health is determined prenatally, for instance through disparities in fetal growth. Overall, the findings of these three essays indicate important directions for future policies and programs to promote human and economic development.

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Chapter 1

1 Introduction

The human development that individuals achieve shapes their wellbeing and determines the development of their economies (Sala-i-Martin, Doppelhofer, & Miller, 2004; Sen, 1999; Suri, Boozer, Ranis, & Stewart, 2011). Education, health, fertility, and labor market participation are some key dimensions of human development that are driven by microeconomic decision making within a context of national policies, programs, and institutions. In part because these areas of economics are extremely complex, many of the policies and programs supporting development have uncertain effectiveness. For instance, developing countries spend hundreds of billions of dollars each year on education, but the rigorous evidence base yields little clear guidance on allocating school resources. Even intuitive interventions such as reducing class sizes do not have strong support (Glewwe, Hanushek, Humpage, & Ravina, 2013).

The deficit of evidence on what works to support development is particularly acute in the Middle East and North Africa (MENA), the only region in the world that has lower economics research coverage than its income or population would predict (Das, Do, Shaines, & Srikant, 2013). This deficit is particularly concerning given the multitude of human development challenges in the region; indeed, a number of unique and thorny human development challenges need to be addressed (Chaaban, 2009; Salehi-Isfahani, 2013; United Nations Development Programme Regional Bureau for Arab States, 2009; World Bank, 2012).

One historical factor that has contributed to the lack of microeconomic research on the MENA region has been a dearth of microdata with which to answer research questions. However, data access has substantially improved over the past few decades as has the quality of data available. It is now possible to assess individuals' economic behaviors using individual and household surveys and to investigate a number of important economic and human development challenges plaguing MENA. This dissertation exploits the increasingly rich landscape of household survey data to investigate several different human development challenges in MENA.

The three essays that form this dissertation examine human development issues through microeconomic and microeconometric analysis. The first essay recognizes that individuals and governments face a multitude of options for investing in workers' human capital. Formal, in-school education is the most common choice for increasing human capital, but individuals also invest in training programs, apprenticeships, and other routes to skills and knowledge outside formal schooling systems. Governments and international development initiatives have generally assumed that formal education is a better route to human capital than non-formal alternatives. The first essay tests the assumption that formal education is the best route to job skills. The returns to formal vocational secondary schooling are compared to the returns to acquiring skills outside the education system, such as undertaking an apprenticeship, for male wage workers in Egypt. A unique longitudinal dataset, with information on schooling and skills, allows for causal inference about returns by comparing siblings, even siblings who have left their natal household. This essay shows that, for recent cohorts, the estimated returns to formal vocational secondary education are the same as attaining *no* formal education, that is, zero. However, the returns to skills obtained outside of formal education are substantial. These findings demonstrate that the assumption that formal education is the best investment in human capital must be re-examined.

The second essay investigates whether declining employment opportunities for women can reverse the fertility transition. The essay presents new evidence that the demographic transition has not just stalled, but in fact reversed in Egypt. After falling for decades, fertility rates are increasing. The drivers of rising fertility rates are examined, with a particular focus on the role of declining public sector employment opportunities for women. By using unique data with detailed fertility and employment histories, the effects of public sector employment opportunities on women's fertility are estimated. Estimates are calculated by examining the effect of public sector employment on the spacing and occurrence of births using discrete-time hazard models, the results of which are then used to simulate total fertility rates. The potential endogeneity of employment is addressed by incorporating woman-specific fixed effects, incorporating local employment opportunities rather than women's own employment, and using local employment opportunities as an instrument. Results indicate that the decrease in public sector employment, which is particularly appealing to women, has contributed to the rise in fertility.

The third essay is motivated by the fact that the first few years of children's lives provide a crucial window for their human development. Malnutrition, as a form of faltering development in the early years of life, has lasting consequences in terms of education, labor market, and adult health outcomes. Early childhood is also the period when inequality originates and the intergenerational transmission of poverty and inequality begins. It is therefore important to identify the causes of poor health in early childhood and to understand what drives inequality in early childhood health and nutrition in order to provide children with equal chances for healthy growth. In Jordan, there are substantial socio-economic disparities in children's health and nutrition. The third essay examines the determinants and mediators of health disparities in children's height and weight in Jordan, focusing on factors that might mediate socio-economic disparities, including parental health knowledge, food quantity and quality, health conditions, the health environment, and prenatal development. While this essay demonstrates that the health environment and food quantity and quality contribute to inequality in child health, these effects mediate only a small share of socio-economic disparities. A large share of inequality in children's health is determined prenatally, for instance through disparities in fetal growth.

Although they address disparate topics, one common thread through all three essays is that they question commonly held assumptions about human development and development policies. In the first essay, the assumption that school is the best route to skills is tested. The second essay's findings contradict the assumption that the demographic transition is an irreversible process. The findings of the third essay demonstrate that the landscape of policies targeting malnutrition in the first few years after birth is based on faulty assumptions about the determinants of deficits in child health.

The three essays also grapple with a number of inter-related challenges in estimating economic relationships using household survey data. A particular concern for estimating causal relationships is endogeneity, including issues such as omitted variables or simultaneity. The essays apply a variety of econometric approaches to address endogeneity. Fixed effects are used for families in the first essay and for individual women over multiple births in the second essay. Instrumental variables are used in the second essay as an alternative approach to overcoming endogeneity. Another econometric difficulty discussed throughout the three essays is the challenge of measurement error, which can have a wide variety of effects on estimates depending on its severity and nature.

All of the questions and econometric estimates in this dissertation are grounded in economic models but also draw on inter-disciplinary literatures. Alternative routes to human capital, such as apprenticeships and training, are added to the returns to schooling debate. The demographic phenomenon of fertility is linked to households' utility maximization decisions. Inequality in children's health is tied to a production function for child health. Drawing on other disciplines crucially informs the models and their interpretation. For instance, evidence on the role of genetic factors in children's health outcomes, based on the genetics and biology literatures, plays an important role in understanding child health inequality.

Together, the three essays, drawing on microeconomic models, microeconometric methods, and inter-disciplinary literatures, make important contributions to our understanding of development economics and the human development challenges facing the Middle East and North Africa. As well as questioning a number of key assumptions in development economics, they contribute important evidence on human development that can help guide policy and programs in the region. While the microeconomic decisions underlying human development processes are complex, it is crucial to understand them in order to promote human and economic development.

Chapter 2

2 Is School the Best Route to Skills? Returns to Vocational School and Vocational Skills in Egypt

2.1 Introduction

Families, students and workers throughout the world struggle to decide what education and training to pursue. Governments also must choose how to invest in the education and training of their citizens. Formal, classroom-based education tends to be the most common choice and policy for increasing human capital—the skills and knowledge that can raise productivity and bring rewards in the labor market. Yet many people also engage in approaches other than formal schooling to develop their human capital, such as on-the-job-training or apprenticeships. When choosing between formal education and alternative routes to human capital, what path should individuals and governments pursue?

Governments have assumed that formal education is the best route to human capital and job skills. This assumption is embedded in government budgets and education systems, which prioritize formal schooling. Global development initiatives also assume that formal education is the best route to skills. For instance, UNESCO's Education for All initiative states that: "Formal secondary schooling is the most effective way to develop the skills needed for work and life" (UNESCO, 2012, p. 4). That formal secondary schooling is the best route to skills[1] is a frequently assumed but as yet unproven hypothesis. This essay tests this assumption by comparing the returns to formal education and alternative routes to skill acquisition for the case of Egypt. Specifically, this essay compares the returns to vocational secondary schooling—a common approach

[1] The term "skills" is not well-defined in the literature and can be used with a variety of different meanings, including as a synonym for education or a particular level of education (i.e. college (Acemoglu & Autor, 2011)), for certain types of knowledge and abilities (i.e. cognitive skills (Hanushek & Wößmann, 2008)) or in terms of specialized occupational knowledge (i.e. carpentry skills (Blattman, Fiala, & Martinez, 2014). This essay generally uses skills as synonymous with human capital unless otherwise specified.

to providing job skills in the formal education system—to the returns to acquiring skills outside the education system, namely undertaking training or an apprenticeship, for male wage workers in Egypt.

What is known about the returns to different types of human capital? There is a substantial body of literature on the returns to education from both developed and developing countries which indicates that formal education is, in general, a worthwhile investment, with positive returns (Card, 1999; Duflo, 2000; Montenegro & Patrinos, 2012; Psacharopoulos & Patrinos, 2004).[2] The methodological and empirical issues in accurately estimating the returns to education are well documented (Card, 1999, 2001; Glewwe, 1996), and there are sufficient studies to have generated some consistency and consensus across studies and methods (Card, 1999; Montenegro & Patrinos, 2012).

Other routes to human capital, outside the formal education system, such as work experience, training, and apprenticeships, have received far less methodological or empirical attention. There are an insufficient number of rigorous studies to assess the value of apprenticeships, even in developed countries, due in part to a shortage of data on the benefits and costs of apprenticeships (Riphahn & Zibrowius, 2015; Wolter & Ryan, 2011). There are a few studies examining the rates of return to training, and these are primarily in developed countries.[3] In contrast to studies on formal education, there is no established functional form that allows for comparison of estimates of returns to training across studies (Frazis & Loewenstein, 2005). Not only is the literature on the returns to human capital acquired outside formal education extremely limited, it also lacks a comparative element—when choosing between formal education or other routes to skill

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[2] Studies of the returns to education are extremely numerous and cover most of the countries of the world. For instance Psacharopoulos and Patrinos (2004) undertake a meta-analysis of the returns to education using studies covering 98 countries. Montenegro and Patrinos (2012) synthesize 545 surveys from 131 different countries.

[3] There is also a large literature on active labor market policies (Card, Kluve, & Weber, 2010; Crepon, Duflo, Gurgand, Rathelot, & Zamora, 2013; Heckman, Lalonde, & Smith, 1999), particularly as welfare policies for the unemployed. This literature has potential implications for the returns to various skills and training for the unemployed, but it is not clear to what extent the findings can inform the returns to different types of human capital for the general population.

acquisition, which is a better investment? It is this vital question that this essay investigates, using the case of Egypt.

A unique dataset, the Egypt Labor Market Panel Survey, allows for estimates of the returns to schooling and skills. In addition to its information on skills and how those skills were acquired, the data set includes actual years of work experience, which is usually not directly measured in surveys. Another key feature of these data is that they follow a panel of households over time, including individuals who split from their households of origin. This allows for inference about the returns to schooling and skills by applying family fixed effects (comparing siblings), an effective method for causal identification of the impact of human capital on earnings (Card, 1999).

This essay shows that among male wage workers in Egypt, especially for recent cohorts, the estimated returns to formal vocational secondary education are essentially zero. Young Egyptians earn as much with a vocational degree as with *no* formal education. However, the returns to skills, specifically craft skills, are substantial. These differences in returns have important implications for Egyptian families and policymakers. Either drastic reforms will be needed to improve the quality and relevance of formal vocational schooling, or alternative routes to job skills—such as apprenticeships and on-the-job training—need to be expanded and encouraged. Globally, the assumption that formal education is the best investment in human capital must be re-examined.

The remainder of the essay proceeds as follows. Section 2 discusses the essay's basic theoretical model: the human capital framework. Section 3 provides background on the education system, alternatives to human capital outside the education system, and returns to schooling and skills. The data are described in Section 4, and the methods for estimating returns in Section 5. Section 6 presents the results on the returns to formal education and to skills acquired elsewhere. Section 7 discusses the implications of the findings and concludes.

2.2 The Human Capital Framework

In order to understand how both schooling and other routes to skills can affect earnings, this essay draws on the human capital framework. In this framework, individuals' skills and knowledge are considered a form of capital, "human" capital, in which individuals can deliberately invest and from which individuals receive returns (Schultz, 1961). Investing in schooling, on-the-job training, health maintenance, and information acquisition are all different ways to invest in human capital, albeit routes with different returns (Becker, 1962). Although the broader nature of human capital has long been recognized, in most economic research human capital is measured as years of formal education. Education increases productivity and yields returns, in the form of higher wages (Mincer, 1974; Rosenzweig, 1995). In contrast, signaling, sorting, and screening models allow education to be correlated with differences among workers that predate their participation in the education system, such as ability (Weiss, 1995). Returns to schooling may therefore not just be due to productivity that was acquired by years spent in school. Education could also serve as an effective signal of innate productivity.

There is growing recognition that years of schooling are an incomplete measure or mis-specification of human capital (Glewwe, 1996; Hanushek & Wößmann, 2008; Pritchett, 2001; Wößmann, 2003). Even those authors who recognize the inadequacy of years of schooling as a measure of human capital nonetheless continue to rely on test scores (in school), school quality, or other formal education-related measures of human capital, neglecting the formation of human capital outside the formal education system.

The assumption that returns to formal schooling are greater than the returns from alternative routes to skill acquisition is embedded in the ongoing focus on formal education as a cornerstone of development. The United Nation's Millennium Development Goals include achieving universal primary education, not achieving universal basic skills (World Bank, 2011). UNESCO's global Education for All Initiative includes a goal of promoting learning and life skills for young people and adults, but assumes that formal secondary schooling is the surest route to skills (UNESCO, 2012). This is a frequently assumed, but untested, hypothesis. This belief is also embedded in government budgets, which allocate large shares of public spending to formal education. For example, in Egypt the education system received 11.7% of 2010/2011 public spending (El-Baradei, 2013). Egypt's new constitution mandates additional investments in education and will make secondary schooling compulsory starting in the 2016/2017 school year (Egypt State Information Service, 2014). This essay tests whether it is in fact true that returns to formal vocational schooling are higher than returns to other routes to skills acquisition—such as on-the-job training and apprenticeships—in the case of Egypt.

2.3 Background

2.3.1 Education in Egypt

Although pre-primary enrollments are rising, most young people enter the Egyptian school system at the primary stage. Figure 2.1 displays the structure of the education system in Egypt. After six years of primary school, young people attend preparatory (lower secondary) school for three years. After preparatory school students are tracked into either vocational or general (upper) secondary school, both usually for three years, based on their test scores. General secondary, which requires higher test scores, is the "academic" track, and almost all general secondary students go on to higher education. Vocational secondary is almost always terminal, with around 9% of students going on to higher education, primarily in two-year programs at post-secondary institutes (Assaad, 2013; Krafft, Elbadawy, & Assaad, 2013). Most vocational secondary students receive a certificate in either commercial or industrial vocational secondary, with a number of students in the agricultural track as well. Vocational secondary schools are almost exclusively public (99%) (Population Council, 2011).

Egypt has steadily expanded its education system over the past several decades. Figure 2.2 displays educational attainment trends by age for males aged 25-64 (of an age to have reached their final educational attainment). The proportion with no formal educational certificate has fallen substantially over time. The share of males who attained only a primary or preparatory education has remained small and relatively flat, as has the share attaining general secondary (which is rarely terminal). The proportion of males attaining a vocational secondary degree has risen steadily, from around 10% of those in their 60s in 2012 to more than 30% of those aged 25 to 40, with nearly 40% of the youngest cohorts attaining vocational secondary. Higher education[4] has also expanded, but more slowly than vocational secondary. Overall, there has been a substantial expansion in education, and this large increase in the supply of educated workers will affect their wages. Additionally, since nearly 40% of recent graduates have a vocational secondary education, the returns to vocational secondary education are of substantial economic importance.

2.3.2 Challenges in the Education System Generally and Vocational Secondary in Particular

Egypt struggles with issues of education quality. Repetition, dropout, and absenteeism are all substantial problems (Elbadawy, 2015; Krafft, 2012). The education system is focused on generating credentials rather than increasing productivity (Assaad & Barsoum, 2009; Salehi-Isfahani, 2012; Wahba, 2001). That Egyptian students are experiencing a low quality of education and limited human capital accumulation is evidenced by students' performance on international tests. Egypt is well below the international average for the TIMSS mathematics and science tests (given to students in the 8th grade), and compared to other countries in the region, Egypt has scores below the level its GDP predicts (World Bank, 2008).

Within the Egyptian education system, the quality of vocational secondary is particularly low, with weak curriculum and materials, poorly trained instructors, and limited connections to the private sector. A recent review of Egypt's national policies for education effectively summarized the state of vocational secondary education: "The technical and vocational education and training (TVET) system is very weak and poorly regarded by Egyptian society, and is an unattractive alternative in its present form" (OECD/World Bank 2010, p. 16). Youth are trained on equipment and skills that are outdated, and the number of vocational secondary students is driven by the supply of

[4] Higher education includes two-year post-secondary education.

young people rather than labor market demand for particular skills (UNDP & Institute of National Planning, 2010; World Bank, 2007). Although the deficiencies in vocational secondary are widely recognized, and numerous reform projects have been implemented, they have not substantially improved vocational secondary education (UNDP & Institute of National Planning, 2010).

The expansion of vocational secondary in Egypt was in part a consequence of public policies that made government employment desirable and educational credentials a pre-requisite for government employment (Antoninis, 2001). Starting in the 1960s, the government guaranteed public sector jobs to all secondary and higher education graduates (Assaad, 1997a). Public sector jobs are particularly appealing to vocational secondary graduates, who obtained a substantial wage premium in the public sector compared to the private sector (Assaad, 1997a; Salehi-Isfahani, Tunali, & Assaad, 2009). The job guarantee is no longer in effect as of the 1990s, and public sector hiring has declined (Amer, 2009; Assaad, 2009). The decreased opportunities for vocational secondary graduates to work in the public sector—and therefore to earn a substantial wage premium—will affect the returns to vocational secondary.

In part due to the problems in the Egyptian education system, especially in vocational secondary, education and labor market mismatch is a serious problem in Egypt (UNDP & Institute of National Planning, 2010). For instance, data from 2009 show that less than half of vocational secondary students who received hands-on training in school and had obtained employment reported that their training reflected the needs of the labor market (Krafft, 2012).[5] Because of the low quality of vocational secondary education, employers sometimes express preference for hiring young people who have *not* attended formal vocational secondary (World Bank, 2013a).

[5] Vocational secondary graduates were asked, “Did you receive any hands-on experience in the school?” Those who reported that they did receive hands-on experience were then asked, “Do you believe that the training you received reflects the needs of the labor market?” These questions were asked only of students in the industrial track (Population Council, 2011).

2.3.3 *Alternatives to Formal Education: Apprenticeships and On-the-Job Training*

Given the poor quality of the formal schooling system, apprenticeships and other forms of on-the-job training are the primary route to job skills for young people in Egypt. Traditional apprenticeships consist of a (male) youth assisting and being trained by a craftsman. Families often have to pay the craftsman for that training (UNDP & Institute of National Planning, 2010). Apprentices typically do not live with craftsmen but remain with their families during training. It is usually a family's social networks and the concentration of craft trades in a community that provide a youth with apprenticeship opportunities (Assaad, 1997b). Craftsmen prefer apprentices under age 18, due to a perception that only young people are able to learn new skills and tolerate the harsh discipline of training (Assaad, 1993). Thus, young people undertake apprenticeships at an age that limits pursuing formal secondary education (Tunali & Assaad, 1992).

After a period of training and very low wages, apprentices can expect to eventually "graduate" to being assistants and ultimately craftsmen themselves.[6] Familiarity and experience with tools and techniques, rather than formal learning, is what matters in the context of apprenticeships (UNDP & Institute of National Planning, 2010). Young people who pursue manual occupations but do not undertake an apprenticeship generally become common laborers, and remain so throughout their careers (Assaad, 1997b; Tunali & Assaad, 1992). The distinction between skilled and unskilled occupations in Egypt is well-defined, and a worker's path is essentially set at first entry into the labor market. For instance, in the construction sector, there is almost no mobility between craft (skilled) and unskilled occupations (Assaad, 1997b).

2.3.4 *Schooling and Work Decisions*

With the choice between formal education and alternative routes to skills, such as apprenticeships and on-the-job training, how do families make school and work decisions? Theoretically, young people no longer attend school when the marginal utility

[6] For instance, in the construction sector it takes two to three years for an apprentice to become an assistant and an additional three to four years for an assistant to then become a craftsman who can work independently (Assaad, 1997b).

of future returns to education is less than the utility lost to schooling costs and the value of their (potentially employable) time (Bacolod & Ranjan, 2008; Becker, 1993; Edmonds, 2008). That a child receives a particular level of formal education is not necessarily the efficient outcome, but only one potential result depending on the returns to different alternatives, such as apprenticeships. Additionally, young people and families faced with school and work decisions do not necessarily subscribe to the same perspective as academics. Schooling decisions are based on a mix of youth and parental preferences over different educational and work options. Information on the returns to education plays a key role in the decision, and while perceived returns to education drive educational decisions, these perceptions may not be accurate, especially in developing countries (Jensen, 2010). In the case of Egypt, future returns may have substantial non-wage components, for instance the prestige of a job (especially the higher prestige of a public sector job), the security of employment, or returns in the marriage market (Assaad, 1999; Barsoum, 2015; Elbadawy, 2009).

There are conflicting perspectives on the impact of early work on human capital accumulation. Early work may compete with human capital accumulation by limiting education (Baland & Robinson, 2000). Alternatively, children engaged in work may acquire skills that increase their human capital (Bourdillon, Levison, Myers, & White, 2010). Families in Egypt often consider children's work to be an opportunity for skill development, with young people who receive on-the-job training perceived as having better prospects for employment. Anecdotally, some youth express a preference for combining school and work, and if this is not possible, they view early work as more important than formal vocational education (Carothers, Breslin, Denomy, & Foad, 2009). This suggests that early work may in fact be more important to human capital accumulation than formal education.

The potential complementarity between schooling and work can also be seen in programs for older children and adults. Apprenticeships and internships can link school with work, helping young people accumulate skills and work experience. The German model of training with a company combined with part-time classroom learning is a prime example. Apprenticeships are also particularly important for the acquisition of job skills that match the needs of the labor market (UNESCO, 2012). Informal combinations of school and work are very common in the developing world but typically are not coordinated to link school and work. Formal, coordinated school/work combinations are much rarer than informal combinations in the developing world, but they do exist. One example is the Mubarak-Kohl Initiative in Egypt. Designed as an alternative to standard vocational secondary schooling, this program consisted of two days in school and four days in a workplace per week, for three years (Adams, 2010).

2.3.5 Returns to Education

The international evidence suggests that Egyptians could expect substantial returns to increases in education. A 2004 review of the returns to education identifies the overall average private return to a year of schooling as around 10% (Psacharopoulos & Patrinos, 2004). This is averaging across all years and types of education for 98 countries. While there is some consensus about individual, micro-economic estimates of returns to education, the macro-economic role of education is less clear. Results from the literature include effectively zero macro-economic returns (Pritchett, 2001), and some micro-economic evidence also supports the lack of returns to education (Glewwe, 1996). However, the macro-economic literature also finds returns that are in fact greater than the micro-economic literature suggests (Krueger & Lindahl, 2001).

Egypt has low private returns to schooling, about half the world average. An estimate based on 2006 data found average returns of 5.4% per year in Egypt (Salehi-Isfahani, Tunali, & Assaad, 2009). The rapid expansion of formal education, as well as the low quality of education and the labor market-education mismatch have all been identified as problems driving low returns in the region (Assaad & Barsoum, 2009; World Bank, 2008). In Egypt, private returns tend to be lower at lower levels of schooling, and highest at the tertiary level (Said, 2015; Salehi-Isfahani, Tunali, & Assaad, 2009), the opposite of the pattern observed globally (Psacharopoulos & Patrinos, 2004).

Globally, there has long been an ongoing debate on the issue of investing in general versus vocational education, with periods of both favoring and disfavoring vocational education (Bennell & Segerstrom, 1998; Bennell, 1996; Oketch, 2014). In individual studies, vocational secondary graduates have been shown to earn higher (Moenjak and Worswick (2003) in Thailand), equal (Pugatch (2014) in South Africa), or lower wages (Newhouse and Suryadarma (2011) in Indonesia) than their general secondary peers. The synthesis of this literature has been inconclusive (Bennell, 1996; Kahyarara & Teal, 2008), and has rarely taken into account alternative routes to human capital accumulation outside the schooling system.

In Egypt, attending general secondary and then higher education definitely generates much greater returns than does a vocational secondary education. Focusing on urban men ages 20-54 in Egypt, Salehi-Isfahani, Tunali, and Assaad (2009) found that, in 2006, the cumulative returns to completing vocational secondary (twelve years of school), as compared to not completing any level of education, were just 30%. Returns to vocational secondary had declined substantially from 1988 to 2006 and were lower in Egypt than Iran or Turkey. The study also found non-linearities in the returns to education, indicating that the standard (linear) Mincer model is not appropriate for Egypt.

Returns to vocational secondary education may in fact have decreased to zero. One of the most recent studies of returns to education in Egypt, using a 2009 survey and focusing on 15-29 year olds, found that the marginal return to secondary education[7] was negative 3% (El-Araby, 2013). This means that continuing from preparatory into secondary yields *negative* returns. However, this study has several econometric weaknesses.[8] The question also remains as to whether the apparent low returns to vocational education are due to low and diminishing returns to vocational skills, or little

[7] The marginal return is relative to preparatory education. Vocational and general secondary education were not distinguished in this study. However, since general secondary education is rarely terminal, the vast majority of individuals attaining only a secondary education are vocational secondary graduates.

[8] For instance, although the regression included a control for gender, estimates were not done for men and women separately. Controls were included for job type, which may itself be influenced by the level and type of education, i.e. secondary certificate holders may be more able to obtain permanent or public sector jobs. Another potential problem is that no effort was made to address selection into different types of education.

or no skills being conferred by vocational education. In contrast, this essay sheds light on this important question by comparing the returns to vocational education with the returns to vocational skills acquired elsewhere.

2.3.6 Returns to Skills

While there are numerous studies on returns to formal education, both globally and in Egypt, there is a very limited body of evidence on the returns to other measures of skills. Some research exists on the returns to cognitive skills (Hanushek, Schwerdt, Wiederhold, & Wößmann, 2013; Hanushek & Wößmann, 2008) and there is some evidence on the returns to training, primarily in developed countries. Almeida and Faria (2014), studying on-the-job training, find returns of 7.7% in Malaysia and 4.5% in Thailand. Almeida and Carneiro (2009), studying firms providing formal job training in Portugal, estimate an internal rate of return to training of 8.6% for the firms that offer training but an average (marginal) internal rate of return of -0.3% for all firms. Frazis and Loewenstein (2007), using U.S. data, find annualized returns of around 40-50% for 60 hours of formal training (training programs or on-the-job training), but also strong evidence of heterogeneity in returns, such that their findings cannot be extrapolated onto the untrained. Frazis and Loewenstein also point out that estimates of returns to training lack a standardized functional form analogous to the Mincer equation for returns to education.

Even in the developed world, there is little evidence on the returns to other key routes to skill acquisition, such as apprenticeships (Wolter & Ryan, 2011). The evidence on the firm side is that investing in apprenticeships can be worthwhile, but this effect is contingent on education and labor market policies (Muehlemann & Wolter, 2014). Although not focused on causal identification, the work of Riphahn and Zibrowius (2015) on Germany's apprenticeship and vocational training system finds positive returns in the labor market that are similar across different types of training.

One of the challenges in evaluating the returns to human capital formed outside the education system, particularly in developing countries, is that programs are heterogeneous, targeting businesses or individuals, providing training on or off the job, and providing very different types of training. McKenzie and Woodruff (2014) review what is known about programs targeting entrepreneurs in micro and small enterprises to provide management and business skills in the developing world and find little evidence, primarily due to a shortage of high-quality studies. Blattman, Fiala, and Martinez's (2014) evaluation of a cash transfer program in Uganda, which provided youth with transfers to pay for vocational training, tools, and start-up costs, found that monthly earnings increased by 38% after four years as a result of the program. Although the authors interpret the effect of the program as alleviating a credit constraint, it also suggests there are substantial returns to skills. Those who received the cash transfer invested in skills training as well as tools and materials and were twice as likely to work in a skilled trade. The resulting increase in earnings, if a result of vocational training, suggests that returns to skills can be quite high.

One of the few pieces of evidence specifically on apprenticeships is a study from Ghana (Monk, Sandefur, & Teal, 2008). For those without education, apprenticeships have a return similar to that for primary education, more than a doubling of income. Evidence on the returns to skills from other contexts is less promising. A randomized experiment evaluating Turkey's vocational training programs for the unemployed found no long run impacts (Hirshleifer, McKenzie, Almeida, & Ridao-Cano, 2014). An evaluation of South Africa's combined classroom learning and on-the-job training program found little impact on employment outcomes (Rankin, Roberts, & Schöer, 2014).

Skills can be task-specific, and there is evidence that task-specific human capital plays an important role in individual wages (Gathmann & Schönberg, 2007), suggesting that there are returns related to both skills and skill/job matches. Mismatches between education and the educational requirements of jobs also can affect returns. There is a lower return to education that is greater than the education required for a job (over-education), as well as a penalty if education is below the education required for a job (under-education) (Dolton & Silles, 2008; Groot & van den Brink, 2000; Hartog, 2000;

Rubb, 2003). The evidence in Egypt suggests that job-specific skills, rather than formal education, are the most important pre-requisite for vocational employment; employability is based on workshop experience (Antoninis, 2001). Overall, while a few studies provide some tentative evidence on returns to skills, this essay addresses a clear need for additional research on skills.

2.4 Data

This essay uses the Egypt Labor Market Panel Survey (ELMPS), a rich panel data set that includes detailed data on individuals' labor market characteristics and histories. The ELMPS was fielded in 1998, 2006, and 2012.[9] It is a household survey, with each round nationally representative at the time of fielding, and with weights that account for attrition processes.[10] The 2012 sample followed previous round households and split households, as well as adding a refresher sample, for a total sample of 12,060 households and 49,186 individuals.[11] Throughout the essay, the panel data are used only for the identification of siblings.[12] Estimates of returns are based only on the 2012 round of the survey.

Using the ELMPS, the essay focuses on wage-earning males aged 15-64 in 2012, who are referred to as the "OLS sample" and described in Table 2.1. This age group is considered the working-age population in the context of Egypt (Assaad, 2009). Ideally, one would examine the returns to education regardless of whether an individual is a

[9] The surveys were conducted by the Economic Research Forum (ERF) and the Egyptian Central Agency for Public Mobilization and Statistics (CAPMAS). See Assaad and Krafft (2013) for additional details on the ELMPS 2012.

[10] Attrition was due to a variety of reasons, including death, migration, and the inability to relocate an individual or household. In 2012, most of the significant predictors of attrition were geographic and demographic characteristics; there were only a few small differences by education or labor market status (Assaad & Krafft, 2013).

[11] Descriptive statistics in this essay use sampling weights. Regressions do not use sampling weights, as unweighted OLS is the preferred approach when the sampling scheme is not based on the dependent variable (Winship & Radbill, 1994). This is the case with the ELMPS, which sampled geographically. In general, if results are homogenous across sub-samples, then unweighted results are more efficient, and if there is heterogeneity, both weighted and unweighted results will be inconsistent, so unweighted methods are preferred (Deaton, 1997).

[12] Since education is fixed once individuals have graduated from school, panel data methods such as fixed effects cannot be used on an individual level.

wage-earner or works in non-wage employment. However, realistically it is not possible to estimate the return to labor, much less human capital, of individuals whose income is from self-employment, including farming. This essay therefore focuses solely on wage earners, who are almost three-fourths of males aged 15-64. In Egypt, effectively all males participate in the labor market, so selection into the labor market is not an issue for this sample. However, female labor force participation is low and there is selection into the labor market for females. Since women have both different labor market behaviors (Assaad & Krafft, 2015a) and different wages, which vary by their labor market characteristics (Said, 2015), this essay examines the returns to education only for males.

An important set of estimates in this analysis are those that compare siblings by using family fixed effects, which exploits the fact that the ELMPS tracks many siblings of working age. The panel nature of the ELMPS allows one to identify siblings even after they have left their natal household, which is particularly important for estimating returns, since income will affect individuals' ability to form new households. The "family fixed effects sample" restricts the sample of wage-earning males 15-64 (the OLS sample) to those who were observed in at least one round (1998, 2006, or 2012) living in their birth household (which makes it possible to identify siblings), with their parent(s) as heads of household. This subset is further restricted to those who, when they were living in their birth household, had a male sibling who is also a wage earner as of 2012. These male siblings are not necessarily living in the same household in 2012. The family fixed effects sample is a 2,300 individual subset of the 8,372 individual OLS sample.

2.4.1 Key Outcome and Explanatory Variables

The key question this essay examines is whether individuals earn higher wages from formal vocational secondary education or from vocational skills acquired through other means. The dependent variable, wages, is the natural log of hourly wages in 2012 Egyptian Pounds (LE).[13] Years of school is measured as the number of years completed.

[13] This measure is the hourly average for all wage compensation, including overtime, bonuses, incentives, profit sharing and any other types of wages. Hourly wages are based on workers' reports of the net amount received in each of these categories, the frequency of receipt, and their hours of work.

The level of education is the highest level an individual completed within the schooling system. The self-reported educational requirements of a job are also controlled for, to distinguish between the returns to different educational requirements and formal education attained, as returns may vary depending on whether education matches job requirements (Dolton & Silles, 2008; Groot & van den Brink, 2000; Hartog, 2000; Rubb, 2003).

The regressions control for actual years of work experience,[14] rather than the more common "potential" work experience (usually age minus years of schooling and school entry age). The regressions also control for the year an individual worked for the first time with dummy variables for different five-year cohorts of labor market entrants. Given the changing economic conditions and policies in Egypt, the timing of labor market entry may affect wages. It is also important to account for regional differences in wages, so controls for the six different regions of Egypt are included.

In terms of skills, individuals were asked, "Does your job require any skill?"[15] and a dummy variable was used to indicate "yes" responses. The coefficient on this variable will indicate the combined returns to having both a skill and a job requiring that skill. Individuals in craft occupations were asked their skill level, specifically whether they were an apprentice, an assistant, or a craftsman.[16] Dummy variables were created for these skill levels, since different skill levels will have different returns.[17]

2.4.2 Descriptives for OLS and Family Fixed Effects Samples

As well as applying ordinary least squares (OLS), this essay estimates family fixed effects models. There are therefore two different samples used in estimation. Table 2.1 describes the characteristics of the samples. The first is the sample of all male wage earners, ages 15-64 ("OLS sample"). This sample has 8,372 observations. These individuals have an average of 9.9 years of school, with 20% not having a completed any

[14] Calculated based on spans of work, in years, from the survey's life events calendar.
[15] Questions were asked in Arabic, with the exact word for skill being literally translated as "technical skill."
[16] The majority of skilled wage workers (54.4%) work in craft occupations.
[17] The reference category is therefore non-skilled or non-craft occupations.

education certificate, 12% having completed primary education, 7% preparatory education, 35% vocational secondary education, 3% general secondary education, and 24% higher education. About 2% of this sample of wage earners is currently in school. More than half (56%) are working in jobs that have no formal educational requirements, while a fifth (19%) are working in jobs that require a secondary education. Two-fifths (41%) are working in jobs that they report require some sort of skill. Looking specifically at the skill level in craft occupations, 1% of the sample is skilled apprentices in craft occupations, 6% are assistants, and 15% are skilled craftsmen in craft occupations, while 78% of the sample is either unskilled or not in a craft occupation. The average wage earned in this sample is 6.4 Egyptian Pounds (LE) per hour.[18]

The second sample is the family fixed effects (male sibling) sample. This sample consists of 2,300 observations from 955 (birth) households, and is denoted "Family FE Sample" in Table 2.1.[19] The most substantial differences between the OLS and family FE samples are in terms of age; the family FE individuals have an average age of 29.5 compared to 35.5 for the OLS sample. This younger sample is due to limiting the analysis to siblings observed together in their natal household in 1998, 2006, or 2012. The family FE sample has years of schooling and levels of schooling similar to the OLS sample. Individuals in this sample are slightly less likely to work in a job that requires formal education: 63% work in a job that requires no formal education, compared to 56% in the OLS sample. However, a similar share work in a job that requires skill, and a similar percentage are at the different levels of craft occupations. The average wage of this

[18] As of 2012, the exchange rate was approximately 6.1 LE to one U.S. Dollar (World Bank, 2013b).

[19] The decrease in sample size from the OLS sample to the family fixed effects sample is due to a number of factors. One is the failure to track split individuals; 30% of the males who would otherwise meet the criteria for inclusion did not have their siblings observed in 2012, the same rate as loss of split individuals in the sample as a whole (Assaad & Krafft, 2013). The greatest loss is due to the fact that of the 8,380 male wage workers ages 15-64, only 4,040 were observed in their natal household in some round. This means the sample is primarily at a certain point in their life course, but this is otherwise unlikely to bias results. The sample is further reduced from 4,040 to 2,534 due to a substantial number of males who did not have a male sibling observed who was working in 2012. Since these males are excluded due to the relatively random patterns of birth order and sibling gender, this is unlikely to cause substantial bias. The final sample reduction from 2,534 to 2,300 is due to the additional limitation that working male siblings must be engaged in wage work. Since relatively little of the sample is lost due to this limitation, it is not likely to engender substantial bias.

sample is 5.8 LE. There are small geographic differences between the two samples. Overall, the family FE sample is quite similar to the sample of all male wage-earners 15-64, bolstering the generalizability of results based on this sample.[20]

2.5 Methods for Estimating Returns to Education and Skills

The traditional method to estimate private returns to education uses the standard Mincer equation, which regresses the log of wages on years of schooling, work experience, and work experience squared (Mincer, 1974):

$$\ln W_i = \beta_0 + \beta_1 S_i + \gamma_1 E_i + \gamma_2 E_i^2 + \varepsilon_i \tag{2.1}$$

where *i* denotes an individual, *W* the hourly wage, *S* the years of schooling, and *E* years of work experience. Throughout, the error term, ε_i, necessarily includes any omitted variables. The coefficient on years of schooling, β_1, is interpreted as the return to an additional year of schooling (in percentage terms).

While the traditional Mincerian approach is very popular, it is not without problems. The empirical evidence suggests that the impact of years of schooling on (log) wages is not linear, but may vary across different levels of education (Psacharopoulos & Patrinos, 2004; Salehi-Isfahani, Tunali, & Assaad, 2009). The Mincer equation can be modified to estimate separate returns for each level of education as follows:

$$\ln W_i = \beta_0 + \sum_j \beta_j L_{ij} + \gamma_1 E_i + \gamma_2 E_i^2 + \varepsilon_i \tag{2.2}$$

where L_{ij} is a series of dummy variables for *j* different levels of education. Returns are then estimated for attaining a certain level of education, rather than per year.[21] Non-

[20] To further test the comparability and generalizability of the family fixed effects sample, a probit was run for the probability of a male wage worker being included in the family fixed effects sample, using the same covariates that are used in the models for returns. Those educated at the preparatory level or higher were significantly less likely to be included than those who had completed no formal education. Those with jobs requiring higher education were also significantly less likely to be included. There were no significant differences in terms of skills. Unsurprisingly, given the need to have been observed in one's natal household, there were significant cohort and work experience differences, with more recent cohorts more likely to be included. In terms of region, compared to Greater Cairo, only urban Upper Egypt was significantly different (more likely to be included). All of the categorical variables, aside from the cohorts, had marginal effects that were less than 10 percentage points. This finding further bolsters the generalizability of the family fixed effects sample.

linearities can be due to credentialism or a "sheepskin effect" (Card, 1999), or they may be due to screening or signaling (Spence, 1973; Weiss, 1995). Screening or signaling theories usually interpret non-linearities as the result of using credentials as signals of human capital or productivity in the face of imperfect information. However, non-linearities may actually occur because credentialed workers have more human capital, the amount of human capital that allows one to successfully complete a level (Strauss & Thomas, 1995).

The Mincerian approach is unlikely to yield causal estimates of the impact of schooling on wages, because differences in ability, school quality and family background can substantially bias estimated returns (Card, 1999; Glewwe, 1996; Wößmann, 2003). A variety of approaches have been used to overcome this problem. The first is to claim that this is not, in fact, a problem, since the standard Mincer estimates have been consistent with higher quality studies that successfully identify causal effects (Card, 1999; Duflo, 2000). Instrumental variables approaches are also common but are not without limitations. First, they require a high-quality instrument to identify schooling decisions. Second, even valid instruments can generate biased estimates in the presence of heterogeneous individuals (Card, 1999). Third, common instruments, such as changes in the structure of the education system and policy, tend to generate local treatment effects that are not necessarily generalizable (Card, 2001).[22] Given that a good instrument is not available in the ELMPS, IV methods are not used in this essay.

Another approach that allows for causal estimates of returns to education is to apply family fixed effects. This process compares the education and wages for siblings,

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[21] The interpretation of a coefficient in these semi-logarithmic equations as a percentage change is an approximation that holds most closely for small changes in continuous variables. For dummy variables, although an interpretation in percentage terms is a close approximation for small coefficients, the coefficient and percentage change diverge as the coefficient increases in magnitude (Halvorsen & Palmquist, 1980). The approximate nature of the percentage change interpretation must be kept in mind throughout.

[22] Card (2001) provides this helpful example as an illustration: assume that the presence of a nearby college is uncorrelated with ability after controlling for observables. College proximity is therefore a potential IV for schooling. However, the correlation between education and ability can be different for those near a college than those far, as is demonstrated empirically. This violates key assumptions for conventional IV estimators, and provides only the local average treatment effect (LATE).

twins, father/son, or mother/daughter pairs. The idea behind this approach is that estimating returns within families substantially reduces the unobservables that bias normal cross-sectional comparisons (Card, 1999). Unobserved differences in ability among siblings can still be an issue with this method. However, Card (1999) shows that ability bias is lower in fixed effects comparisons of twins or siblings than in OLS or IV estimates.

The fixed effects approach is particularly effective at diminishing bias in countries where family characteristics play a large role in educational outcomes, as is the case in Egypt (Assaad, 2013; Krafft, Elbadawy, & Assaad, 2013).[23] Family characteristics also play a large role in selection into different occupations and skills. For instance, an individual with family working in craft trades in the construction sector is significantly more likely to enter craft work himself (Assaad, 1997b).[24] Family characteristics can also have direct impacts in the labor market even after accounting for human capital (Assaad, Krafft, & Salehi-Isfahani, 2014).

Measurement error in schooling or skills can also affect estimates, usually biasing them downward (Card, 1999; Glewwe, 1996). One drawback to within-family estimates is that measurement error creates larger downward biases than for other methods (Angrist & Krueger, 1999; Card, 1999). However, measurement error will affect reports of both education and skills,[25] so the relative returns of schools and skills may be less distorted.

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[23] For instance, a disadvantaged male from rural Upper Egypt (the country's poorest region) with illiterate parents and from the bottom wealth quintile can be compared with an advantaged male who lives in the urban governorates, has parents with university education, and who is from the top wealth quintile. While the disadvantaged male has a 44% chance of a less than secondary education, the chance for the advantaged male is essentially zero. The disadvantaged male has a 47% chance of a secondary degree and the privileged male a 3% chance. The disadvantaged male has a 9% chance of a university education, while the advantaged male has a 97% chance (Assaad, 2013).

[24] There is a strong pattern of intergenerational occupational transmission in Egypt, particularly in craft trades. For instance, while just 12.5% of all males 15-64 work in building trades, 40.0% of those men whose fathers were in the building trades themselves work in building trades. This pattern is particularly strong for smaller trades; while just 3.8% of men work as cabinet makers (or related trades), 21.7% of men whose fathers were in the cabinet trade themselves end up in this work. This pattern is not as pronounced in other, non-craft occupations. For example, while 7.2% of men work in sales and service jobs, 12.0% of men whose fathers worked in sales and service themselves work in sales and service, a much weaker pattern of intergenerational transmission.

[25] It is possible to obtain some sense of the potential severity of measurement error by comparing reported education from male wage workers past school age in the panel from 1998 to 2006 (not everyone was re-

To control for other important factors, a number of additional variables can be incorporated into the model as controls, X_{ij} , where j denotes different dummy variables for regional categories and for five-year labor market entry cohorts. Controls are also included for the categorical education requirements of a job, R_{ij} , where j denotes different education categories, such as a job requiring a university education. With the addition of these controls, the Mincerian levels model can also be extended to include the private returns to skills as:

$$\ln W_i = \beta_0 + \sum_j \beta_j L_{ij} + \sum_j \delta_j K_{ij} + \gamma_1 E_i + \gamma_2 E_i^2 + \sum_j \theta_j R_{ij} + \sum_j \mu_j X_{ij} + \varepsilon_i \quad (2.3)$$

where K_{ij} is a dummy variable for whether individual *i* has a skilled job or skill level j. The coefficients on skills, δ_j, represent the returns to having both a skill and a job that requires that skill, and can be contrasted with combinations of β_j and θ_j, the returns to education and to having a job that requires a specific level of education, respectively. By controlling for both work experience and education, estimated returns to skills will also exclude the level of skills accumulated through education or acquired based on simply time spent in a job, and thus be more representative of acquiring skills outside of education or daily experience.

For individual *i* from natal household *h* one can estimate equation (2.3) as a family fixed effects model:

$$\ln W_{ih} = \beta_0 + \sum_j \beta_j L_{ihj} + \sum_j \delta_j K_{ihj} + \gamma_1 E_{ih} + \gamma_2 E_{ih}^2 + \sum_j \theta_j R_{ihj} + \sum_j \mu_j X_{ihj} + \eta_h + \varepsilon_{ih} \quad (2.4)$$

asked in 2012). Vocational secondary education, the schooling level of interest, appears to be relatively well measured in the data, as 87% of those reporting vocational secondary in 1998 made the same report in 2006. Unfortunately, similar comparisons cannot be made to determine the accuracy of skills, since whether an individual works in a job that requires skills can genuinely change over time.

where the family fixed effect, η_h, allows any unobservables that do not vary within the family to be differenced out when comparing siblings. In order for this method to generate a causal estimate of the returns to education and skills, certain assumptions have to hold. Ideally, the error term would be orthogonal to siblings' schooling and skills. This means that unobservables that do vary within the family, such as differences in ability and aptitude between siblings, would have to be unrelated to schooling and skills. Although most of the unobservable differences are likely to be removed by family fixed effects, this method is unlikely to eliminate *all* bias. There may be selection into both education and other forms of skill acquisition even among siblings. However, some assessment of the direction of bias can be undertaken. Results are presented below which show that, between siblings, the more able (those with higher test scores) are selected into additional education.

2.6 Findings

2.6.1 Education, Skills, and Employment

One apparent consequence of the dramatic expansion of education in Egypt is that individuals often work in jobs that they report require lower education than they have obtained. Table 2.2 presents the percentage of employed males working at a job that requires an education level *below* the education level they have attained, by educational attainment. Additionally, Table 2.2 shows the percentage of employed males working at a job that requires *no* formal schooling, by educational attainment.[26] Overall, about half (51%) of workers report that they have a job that requires education below their educational attainment, and slightly more than half (55%) report that they are working at a job that in fact requires no formal education, which suggests a large mismatch between the education system and the labor market. Notably, nearly two-thirds of vocational

[26] The educational requirements of a job are self-reported but the distributions of responses of no education required across different occupations (Table 2.9) and economic activities (Table 2.10) are consistent with expectations. For example, while 94.8% of agricultural workers report that their job requires no formal education, just 1.7% of individuals engaged in professional, scientific, or technical activities report that their job requires no education.

secondary graduates (63%) are working at jobs that they report require less than their education level and half (49%) are working at jobs that they report require no formal education whatsoever. The supply of educated graduates has expanded well beyond the demand for educated workers. This problem affects the majority of vocational secondary graduates and will reduce the returns they can obtain for their education.

Slightly less than two-fifths (39%) of employed males 15-64 work at jobs that they report require a specific skill (Table 2.3).[27] While only 28% of illiterate males work in skilled jobs, males with a primary education or higher have similar chances (between 39% and 45%) of reporting being in a skilled job, regardless of their education level. Individuals with less than a secondary education who report working in a skilled job primarily learned their skills on the job or through a craftsman (i.e. in an apprenticeship). Notably, only 18% of vocational secondary educated individuals in jobs requiring a skill learned that skill in vocational secondary education. The combined low level of skilled work and acquiring skills through vocational secondary means that out of all vocational secondary graduates, just 7% are engaged in skilled work using skills from vocational secondary education.

More often, vocational secondary graduates working in a skilled job learned their skills through a craftsman (in an apprenticeship) (40%). On-the-job learning was also a common route to skills (22%). The share of men with lower education levels learning their skills through a craftsman was 62%-65%, which is comparable to the sum of vocational secondary graduates who learned their skills either via vocational secondary or from a craftsman. This indicates that vocational secondary education and apprenticeships, as routes to skill acquisition, have the potential to be substitutes. However, that vocational secondary graduates were more than three times as likely to have learned their skills from a craftsman or on the job as from their vocational education indicates that vocational secondary is a poor source of job-appropriate skills.

[27] Skills are self-reported but are distributed across occupations (Table 2.11) and economic activities (Table 2.12) with a clear and predictable skill gradient. For instance, just 13.0% of salespersons report they hold a skilled job, compared to 86.5% of machinery and related trades workers.

Ideally, wages reflect workers' marginal productivity; in reality, they often reflect a mix of marginal productivity and other factors, essentially portraying wages associated with an education or career path. Table 2.4 presents mean and median hourly wages in 2012 LE by educational attainment among male wage workers. The mean wage across all levels of education is 6.40 LE, and the median wage is 4.50. Mean and median wages for lower levels of education show only minor variation. Vocational secondary graduates have slightly higher wages than those with less education; median wages are 0.28 LE per hour higher than median preparatory wages, and the mean gap is 0.90. The largest difference is at the level of university, where both mean and median wages rise substantially.

The higher wages associated with vocational and university education are in large part a product of high public sector wages. However, as the government has attempted to decrease the size of the public sector and as the supply of graduates has increased, the relationship between wages and education has changed. Figure 2.3 presents wages by education level[28] and years of work experience. Youth with 0-10 years of work experience have very similar wages if they have no education or any education up through vocational secondary education. Only higher education has a higher return. While wages rise somewhat with years of work experience for vocational secondary graduates, the gradient is fairly slight, especially compared to higher education. Young people would be as well off, in terms of wages, without any formal educational certificate as they would be having attained a vocational secondary education.

2.6.2 Returns to Education and Skills Using OLS

Estimating the standard Mincerian equation for 15-64 year-olds (Table 2.5, specification 1) the rate of return to education is 4.1% per year. However, as seen in Figure 2.3, returns to education appear to have substantially diminished for recent graduates. Specification 2 therefore restricts the sample to young males, ages 15-34 in 2012. These are individuals who would have been of working age starting in the mid-

[28] Post-secondary institutes and university & above have been combined into the category "higher education," which is used hereafter.

1990s and thereafter, and would have been facing the end of the government employment guarantee for educated graduates. Looking at these 15-34 year olds, the return to education is 2.2% per year. This is a substantial decrease from the return experienced by the older generation (ages 35-64) of 5.3% per year (specification 3). Increases in the quantity of education, the increasing share of vocational secondary education, and the end of the government employment guarantee may all be contributing to the very low returns to education for young people in Egypt.

The standard Mincer equation can serve as a helpful reference and, consistent with previous research, demonstrates that the returns to education in Egypt are quite low. However, there are also substantial non-linearities in the returns to education in Egypt. Specifications 4 through 6 therefore estimate the returns to education using the level of education attained, with the different educational attainments compared to the reference category of an individual who is illiterate or can read and write but did not complete any formal education. These specifications also include a series of five-year labor market entry cohort dummies, to adjust for different wages facing later cohorts, and controls for regional wage differences. Although not shown, these controls tend to be significant. Looking at the returns to different levels of education for 15-64 year-olds (specification 4) the cumulative returns to vocational secondary are 21.7%. The substantial non-linearities in returns to education are obvious in specification 4, since different levels of education have very different returns.

Since returns to education, and especially vocational secondary, appear to have substantially diminished for recent graduates, specification 5 re-estimates specification 4 with a sample restricted to males aged 15-34 in 2012. These are individuals who have a particularly high rate of vocational secondary attainment (Figure 2.2) and low wages associated with vocational secondary education (Figure 2.3). Looking at these 15-34 year olds, the returns to vocational secondary are near zero and not statistically significant. The direction of bias in these regressions, in terms of selection on ability, or even the type of family connections that will yield more advantageous employment, is, if anything, likely to bias results in favor of higher returns to increasing levels of education.[29] Therefore, finding that for 15-34 year olds the returns to completing a vocational secondary education—twelve full years of school—are statistically indistinguishable from remaining uneducated is remarkable. It is also a substantial change from the experience of older Egyptians (ages 35-64), for whom all levels of education generate substantially higher returns, vocational secondary particularly so, with a return of 40.4% compared to remaining uneducated.[30]

The differences in returns across generations are in large part due to changes in public policy, specifically in terms of government hiring and compensation, particularly for vocational secondary graduates. As Table 2.6 shows, there are large premiums to education for public sector workers 35-64 years of age in 2012. Compared to uneducated workers, vocational secondary graduates in the public sector have 69.3% higher wages. In the private sector, this difference is just 11.7%. Additionally, more than half of 35-64 year-old male wage workers are employed in the public sector. In contrast, among 15-34 year-olds, there is now zero return to vocational secondary in the public sector (and only 16% of vocational secondary educated male wage workers ages 15-34 are in this sector), and just a 5.6% return to all twelve years culminating in a vocational degree in the private sector.[31] The premium to vocational secondary in the public sector that the older generation enjoyed no longer exists for the younger generation.

As an alternative to investing in formal vocational education, should young people invest in other routes to vocational skills? Table 2.7 investigates the returns to

[29] More able students progress further in school; one of the most common reasons for dropping out of school is not doing well in school (Population Council, 2011).

[30] The differences across generations in the returns to vocational secondary are also visible when comparing returns in different rounds of the ELMPS. The exact same specification cannot be used, because actual work experience is not available in all rounds; age less school start age and years of school must be used for work experience. For individuals 15-34 in 1998, the return to vocational secondary was 17.5%. For those 15-34 in 2006, the return to vocational secondary was 11.4%. For those 15-34 in 2012, using the same specification, the return to vocational secondary was 9.3%. All returns were statistically significant. Using this specification, the returns to vocational secondary have thus been halved for young Egyptians over the 14 years from 1998 to 2012.

[31] The change across generations is not due to differences in the skill level of jobs by age or sector; public and private sector workers have similar probabilities of skilled jobs, and there are not very different patterns by age.

holding a job that respondents report requires skills, and additionally the returns to different levels of skill in craft occupations, after controlling for an individual's education level and the job's education requirements. After adding the job's education requirements and skills, the returns to vocational secondary for 15-64 year-olds have dropped from 21.7% (specification 4, Table 2.5) to 14.9%[32] and the returns to a job that requires secondary[33] education are 14.2%. Vocational secondary graduates' returns are mediated through job education requirements due to wage premiums for public sector jobs requiring vocational secondary, even after accounting for skills (not shown).[34]

Focusing on 15-34 year olds, and incorporating job requirements and skills in specification 8, the return to vocational secondary is again near zero and statistically insignificant. There is also no statistically significant return to obtaining a job that requires secondary education. The sum of the vocational secondary coefficient with obtaining a job that requires secondary education is statistically significant, but the sum is just a 7.2% return relative to remaining without education in a job that requires no education. In contrast, for 35-64 year olds (specification 9), after accounting for skills the return to vocational secondary education is 20.3% and the return to a job that requires secondary education is 25.0%. Vocational secondary education's benefits have dropped substantially across generations; given the opportunity cost, and cost to society of educating these individuals for an additional three years, vocational secondary appears to be a very poor economic investment, yielding no higher wages than remaining uneducated.

Compared to the return to vocational secondary, skills are a substantially better investment. Among 15-64 year-olds (specification 7), the return to an individual's job requiring any skill is 10.2%. Although apprentices and assistants in craft trades obtain no

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[32] There are essentially no changes to the returns to education if skills and skill levels are added without adding the educational requirements of a job (not shown), which suggests that education and skilled work are essentially orthogonal, consistent with Table 2.3.
[33] Job requirements are self-reported and do not distinguish between general and vocational secondary. Since general secondary is not generally terminal, jobs requiring a secondary education will usually be expecting a vocational secondary degree.
[34] Most jobs requiring an education are in the public sector (59% of jobs requiring a secondary degree are public sector jobs).

higher returns than other skilled workers, craftsmen in craft trades receive a 8.4% return to their skill level—on top of the return to a job that requires a skill. This is notably higher than the return to vocational secondary education, although less than the return to vocational secondary education and obtaining a job that requires that level of education.[35] When restricting specification 7 to 15-34 year olds (specification 8), the return to skills persists at 8.4%, and the returns to being a craftsman actually rise to 11.4%.[36] For 35-64 year-olds, the return to skills is 10.8%, and craftsmen receive an additional 6.7% (the latter is insignificant, but also difficult to distinguish from having a skill in this older age group as very few older men are assistants or apprentices). So while vocational secondary returns have fallen to zero for 15-34 year olds, the returns to skill and the additional effect of becoming a craftsman remain similar across generations.

2.6.3 Returns to Education and Skills Using Family Fixed Effects

While OLS regressions are commonly used for estimating returns to education, they are potentially biased due to omitted variables.[37] One method for removing bias from estimates of the returns to education is the use of family fixed effects. By comparing two or more siblings from the same family, bias associated with family characteristics will be removed. Bias related to individual characteristics—including ability—is likely to remain. However, in Egypt, family characteristics strongly shape both educational attainment and job access. The direction of bias related to individual ability can also be signed by looking at observable measures of ability. Self-reported test scores[38] (out of 100) can be compared among siblings in the family fixed effects sample whose

[35] Vocational secondary graduates do not receive differential returns to their skills. Skill and skill level interactions with education levels showed no statistically significant interactions for vocational secondary graduates.

[36] The returns to skill are not driven by returns for those with general secondary or higher education; for both 15-64 year-olds and 15-34 year-olds the returns to skills and skill levels are similar when general secondary and higher education graduates are excluded.

[37] For instance, when adding observable parental characteristics (education and employment characteristics) to Specification 7, parental characteristics are statistically significant, and their addition also reduces the returns to education. Unobserved family characteristics are likely to be further biasing the results.

[38] Individuals have to pass an exam to complete a level of school, and it is the scores on these tests, at the end of primary and the end of preparatory, that are reported in the ELMPS. Data is collected only for individuals 45 and younger, if they attended a given level. Many individuals also do not recall their scores.

households have variation in education or skills. The difference in test scores in terms of education was that those siblings who were most educated had 7.3 point higher primary test scores and 2.6 higher preparatory test scores compared to their less educated siblings.[39] This indicates that even within families, siblings with higher ability attain more education, yielding a bias in favor of finding higher and positive returns to education even within families. In contrast, siblings who obtained skills or became craftsmen tended to have lower academic ability as measured by test scores. Siblings who had skilled jobs had 1.4 point lower primary test scores and 0.9 lower preparatory test scores than siblings with unskilled jobs.[40] Siblings who were craftsmen had 1.8 point lower primary test scores and 0.3 point lower preparatory test scores than siblings who were not craftsmen.[41] More academically able siblings continue in school, while the less able drop out and work in craft or skilled trades. Thus, ability bias is likely to inflate the returns to school and (slightly) deflate the returns to skills acquired elsewhere.[42]

Table 2.8 presents the estimates of returns to education for the family fixed effects sample.[43] Estimates for ages 15-64 and 15-34 are presented; there are too few males 35-64 with siblings of the same age who were observed in their natal household to present

[39] The average primary score of a less-educated sibling was 69.6 and the average primary score of the most-educated siblings was 76.9. Likewise in preparatory the average test score of a less-educated sibling was 66.1, while the average test score of a most-educated sibling was 68.7.

[40] The average primary score of siblings who did not have a skilled job was 78.3, compared to 76.9 for siblings who did have a skilled job. The average preparatory score was 72.4 for siblings who did not have a skilled job and 71.5 for siblings who had a skilled job.

[41] The average primary score of siblings who were not craftsmen was 75.2, compared to 73.4 for siblings who were craftsmen. The average preparatory score was 70.2 for siblings who were not craftsmen and 69.9 for siblings who were craftsmen.

[42] The pattern of selection on unobservables into higher levels of education and away from skilled craft occupations is consistent with estimates of selection based on observables (Altonji, Elder, & Taber, 2005; Oster, 2013).

[43] The family fixed effects model identifies returns based on households that vary in terms of their characteristics. In the 2,300 individuals and 955 households in the family fixed effects sample, 1,395 individuals in 551 households vary in education, with 1,000 respondents in 386 households having variation in vocational secondary. There are 861 respondents in 337 households with variation in having a job requiring skills and 533 respondents in 206 households with variation in being a craftsman. While a larger sample might allow for more precise estimation, for the variables of interest there is sufficient variation to expect reasonable estimates.

models separately for this age group.[44] The linear returns to education using family fixed effects are substantially lower than the OLS returns. The standard Mincerian return to a year of school is only 1.8% for ages 15-64 (specification 10), about one-fifth the international average (Psacharopoulos & Patrinos, 2004). Among 15-34 year-olds, the linear returns are not significantly different from zero. Looking at the returns to different levels of education in the family fixed effects model, among 15-64 year-olds, the return to vocational secondary is 10.2%, significant at only the 10% level (specification 12). For 15-34 year olds, there is no level of education that has a statistically significant return (specification 13).

Although the returns to education are substantially diminished in the family fixed effects model, suggesting that the OLS models for returns to education were biased upwards,[45] the returns to skills—specifically, becoming a craftsman—remain substantial. In specification 14, for 15-64 year-olds, the return to vocational secondary is insignificant. The returns to having a skill, and obtaining a job that requires a skill, are essentially zero and insignificant. However, the returns to attaining a craftsman level of skill, in a craft trade, are 17.7%. Being a craftsman has the same return as higher education. Restricting to the sample of 15-34 year olds, it is notable that the return to being a craftsman for this age group is 20.3%. The return to vocational secondary education is near zero and insignificant, although the return to obtaining a job that requires secondary is 15.4%. The family fixed effects model indicates that the returns to education are lower than the (already low) estimates obtained from the OLS model. Vocational skills acquired outside the formal schooling system, specifically apprenticing

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[44] There are 262 individuals from 121 households with at least two males 35-64 within the fixed effect sample.

[45] The lower returns in the 15-64 year-old sample are due in part to the higher share of young adults in the 15-64 year-old family fixed effects sample than in the 15-64 year-old OLS sample. Running OLS on the 15-64 year old fixed effects sample generates returns that are lower than in the full 15-64 sample but higher than once fixed effects are applied. However, when running OLS on the 15-34 year-old family fixed effects sample, the returns to education are similar or higher to those using the 15-34 year-old OLS sample. This indicates that, once age differences across the samples are accounted for, it is not differences in the OLS versus family fixed effects samples that drive differences in returns.

in a craft trade and ultimately becoming a craftsman, are consistently a better investment for young people than formal vocational secondary education.

2.7 Discussion and Conclusions

Historically, there have been high private returns to vocational secondary education in Egypt. However, these high returns occurred due to high public sector wages and the public sector employment guarantee (Assaad, 1997a; Salehi-Isfahani, Tunali, & Assaad, 2009). OLS estimates suggest that there remain positive private returns to vocational secondary education, as compared to no formal education, for males 15-64. Returns to education estimated using OLS are unlikely to be causal estimates. Therefore, to obtain causal estimates, this essay compared male siblings who were wage earners. Returns to education were notably lower for all levels of education using this estimation technique. However, focusing on male youth 15-34, there were essentially no returns to vocational secondary education with either family fixed effects or OLS. Young men receive the same wages after twelve years of education, culminating in a vocational secondary degree, as they would have if they had not attended school at all.

In sharp contrast to the nil returns to vocational secondary education, the returns to skills are substantial. For men 15-64, in the OLS model the rate of return to a job that requires skill is estimated to be around 10.2%, and achieving the craftsman level in a craft trade confers an additional 8.4% return. These returns hold for young males as well. While the returns to obtaining both skills and a job that requires those skills generally did not persist in the family fixed effects model, the returns to being a craftsman in a craft trade were 17.7% in the working-age family fixed effects model. Moreover, the estimated coefficient on becoming a craftsman was similar for youth age 15-34 as for 15-64 year-olds and remained significant. The family fixed effects estimates confirm that youth receive higher returns from investing in alternative routes to vocational skills—specifically, apprenticing in a craft trade in order to become a craftsman—than from investing in vocational secondary education. Despite the fact that the returns to skills acquired elsewhere are higher, young people may still prefer to attend vocational secondary education for other reasons, especially a chance at a public sector job, with the associated non-monetary benefits[46] and higher prestige.[47]

A substantial amount of money is spent on vocational secondary education, supposedly to provide young people with job skills. In Egypt, education is nominally free of charge. While there are associated costs, and indeed, often quite substantial private expenditures (Assaad & Krafft, 2015b; El-Baradei, 2013), the largest cost is that the government is funding a vocational secondary education for around two-fifths of each recent birth cohort. This investment will be further expanded when secondary education becomes compulsory in the 2016/17 school year (Egypt State Information Service, 2014). Public investment in education can be justified on a number of grounds, but all rest upon young people benefiting from that education. Yet the different methods consistently indicated that young vocational secondary graduates earn no higher wages and are no more likely to be in a skilled job. Thus, "investing" in vocational secondary education appears to have no economic benefits.

It could be argued that vocational secondary should be reformed. However, given that the problems with vocational secondary have been recognized for decades, and the long list of reform attempts (Adams, 2010; Antoninis, 2001; OECD/The World Bank, 2010; Wally, 2012) that have been tried with no discernable improvements, this route does not show much promise. Perhaps vocational secondary should be abandoned entirely, a policy that would yield substantial budgetary savings to society. Young people who tested into general secondary at the end of preparatory could then continue on for

[46] The ratio of non-wage benefits to wage benefits in the public sector has been estimated to be approximately 1:1 (Assaad, 1999); non-wage benefits are much rarer in the private sector.

[47] Two other possible benefits of attaining a vocational secondary education that would not be reflected in the returns to education could be higher chances of employment or improved migration opportunities. Male vocational secondary graduates have a 4.7% unemployment rate, higher than preparatory graduates (2.4%), which suggests that there are no substantial benefits of vocational secondary in terms of accessing employment (Assaad & Krafft, 2015c). Migration plays a large role in the Egyptian labor market. Migration is essentially exclusive to men (Wahba, 2015). Estimates are that around 14% of Egyptian males ages 25-34 are either previous (return) migrants or current migrants (Assaad & Krafft, 2014). Migrants tend to be slightly more educated than non-migrants. For instance, 49% of all migrants who left the country over 2000-2009 had a secondary education (Wahba, 2015). This is slightly higher than the share of young men with a secondary education in Egypt (see Figure 2.2). So secondary education may also slightly increase the chances of migration and provide a benefit through that avenue, but this avenue is not exclusive nor disproportionately likely for secondary graduates as compared to other young men.

general secondary and higher education; young people who did not would stop at the end of preparatory, around age fifteen, and enter into the labor market. There are myriad alternative uses for vocational secondary's funding—such as paying for skills training, tools, and start-up costs, a worthwhile strategy in Uganda (Blattman, Fiala, & Martinez, 2014), or improving the quality of basic education, which is more likely to generate public returns. Vocational secondary schools could also be transformed into general secondary schools, although the value of broadly providing general secondary education requires further research.

Abandoning vocational secondary, either for general secondary or earlier school exit, would leave young people with only the more effective routes to skills. While not all young men would become apprentices and ultimately craftsmen,[48] none would experience a costly form of education that generates no returns. Other forms of work-place training and apprenticeships outside the craft trades are also likely to be valuable, and should be researched and encouraged.

Ending vocational secondary education would also address Egypt's education/labor market mismatch. That most educated men are in jobs that do not require their education, or frequently that do not require any education at all, is just one illustration of this mismatch. The results of this essay suggest that mismatch, characterized by low returns, is more of a problem when skills are acquired in the education system than through alternatives such as apprenticeships. The mechanisms underlying this result are important, and merit consideration in vocational policy. First, employers have much better information on what skills are in demand (since they demand them) than the education system or students. Second, while vocational secondary education trained students essentially regardless of labor demand (UNDP & Institute of National Planning, 2010; World Bank, 2007), craftsmen are very unlikely to take on apprentices without work for them to do. These information and labor demand issues make it difficult for the education system to perform as well as employers in providing

[48] Additionally if many more individuals shifted into this form of human capital accumulation, with an increase in the quantity of skills in the workforce, the returns would likely drop.

training—particularly when private sector employers are not in any way linked to the education system. Employer-driven training for current workers and new hires may therefore be a better approach to matching workers' skills with the skills demanded by the labor market.

The fact that acquiring vocational skills through an apprenticeship, and ultimately becoming a craftsman, yields higher returns than vocational secondary education has important implications not only for young people and the government in Egypt, but also for development policy worldwide. A sizeable body of literature indicates that there are high returns to capital for microenterprises (de Mel, McKenzie, & Woodruff, 2008). This literature drives the push for microfinance as a development tool. However, the education-employment mismatch in Egypt suggests that a lack of opportunities to form appropriate *human* capital is limiting development.

The economic literature on human capital has over-emphasized formal education. While there are numerous returns to education studies, this is one of very few studies examining the returns to human capital acquired outside the formal education system. This deficit needs to be redressed, with substantial additional research on skills acquisition and the returns to skills, as well as other forms of human capital. The bias in favor of formal schooling is also apparent in government budgets and the efforts of international organizations. The targets of the Millennium Development Goals include schooling goals but not skills goals (World Bank, 2011). The Education for All Initiative includes a goal of promoting learning and life skills, yet states, "Formal secondary schooling is the most effective way to develop the skills needed for work and life" (UNESCO, 2012, p. 4), a frequently assumed hypothesis that—in the case of Egypt—does not appear to hold. The primacy of formal education needs to be re-evaluated in light of these findings.

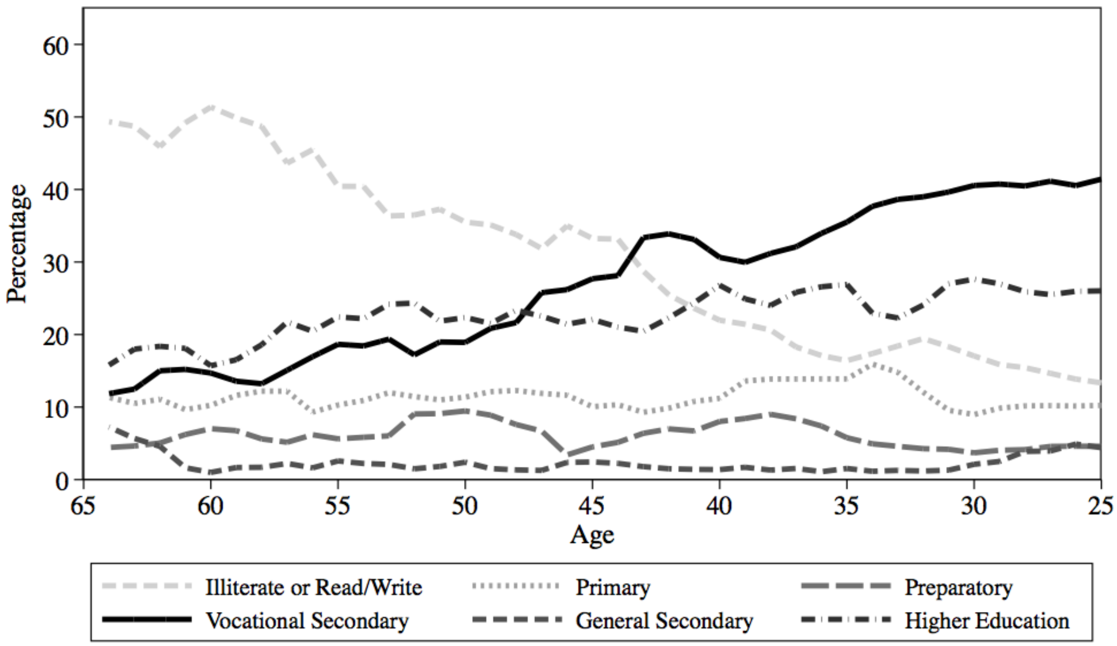
Figures

Figure 2.1. Structure of the Egyptian Education System

		Vocational Secondary	**Post-Secondary Institutes**
		Grades 10-12	Two-year
		Usually terminal	
Compulsory Schooling			
Primary ⇒	**Preparatory** ⇒		**Higher Institutes**
Grades 1-6	Grades 7-9		Four-year
		General Secondary ⇒	**University**
		Grades 10-12	Four-year
(Ages 6-11)	(Ages 12-14)	(Ages 15-17)	(Ages 18 and up)

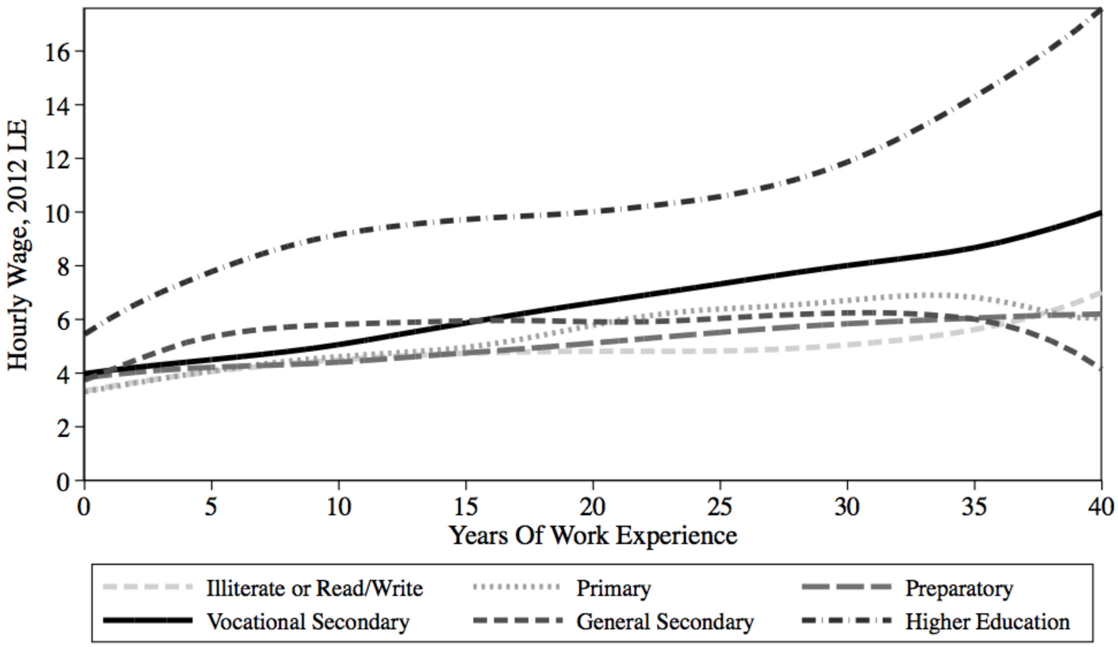
Note: Ages in parentheses are ideal, assuming on time entry and no repetition.

Figure 2.2. Educational Attainment by Age, Three-Year Moving Averages, Males, Ages 25-64



Source: Author’s calculations using ELMPS 2012.

Figure 2.3. Smoothed Mean Hourly Wages (in 2012 LE) by Educational Attainment and Years of Work Experience, Male Wage Workers, Ages 15-64, 0-40 Years Work Experience



Note: Lowess smoother with bandwidth 3.
Source: Author's calculations using ELMPS 2012.

Tables

Table 2.1. Sample Descriptives

	OLS Sample	Family FE Sample
	Percentage of Sample	*Percentage of Sample*
Current Student	2.1	2.5
Education Level		
Illiterate or Read/Write	19.7	17.7
Primary	12.0	13.7
Preparatory	6.8	6.8
Vocational Secondary	34.7	37.1
General Secondary	2.5	2.9
Higher Education	24.3	21.8
Required Education for Job		
Illiterate or Read/Write	55.5	63.0
Primary	4.1	4.0
Preparatory	2.5	2.2
Secondary	18.5	15.8
Higher Education	19.4	15.0
Region		
Greater Cairo	19.4	15.8
Alexandria & Suez Canal	8.8	8.7
Urban Lower	9.3	8.4
Urban Upper	7.2	8.7
Rural Lower	31.6	31.1
Rural Upper	23.6	27.3
Job Requires Skill	41.1	40.6
Skill Level, Craft Occupations		
Not Skilled or Not a Craft Occupation (Reference)	77.6	74.8
Apprentice	1.2	1.4
Assistant	5.8	7.4
Craftsman	15.3	16.4
	Means (Standard Deviations)	***Means (Standard Deviations)***
Years of School	9.89	9.81
	(4.80)	(4.37)
Age	35.50	29.52
	(11.07)	(7.33)
Years Since First Job	18.30	12.58
	(11.68)	(7.87)
Years of Work Experience	16.94	11.78
	(11.25)	(7.53)
Hourly Wage (2012 LE)	6.40	5.81
	(12.46)	(19.38)
Observations (N)	8,372	2,300

Notes: OLS sample is male wage earners 15-64. Family FE sample is male wage earners 15-64 who were sons of the household head in 1998, 2006, or 2012, and had a male sibling who was also a wage earner in 2012.
Source: Author's calculations using ELMPS 2012.

Table 2.2. Education Requirements of Jobs by Education Level, Employed Males, Ages 15-64 (Percentages)

	Job Requires an Education below Education Attained	Job Requires no Formal Schooling
Illiterate	0.0	93.0
Reads & Writes	73.9	73.9
Primary	87.1	73.2
Preparatory	86.9	63.9
General Secondary	58.7	46.5
Vocational Secondary	63.1	49.0
Post-Secondary Inst.	57.5	19.1
University & Above	30.5	12.9
Total	50.5	54.9

Source: Author's calculations using ELMPS 2012.

Table 2.3. Job Skills and Skill Acquisition, Employed Males, Ages 15-64 (Percentages)

	Illiterate	Reads & Writes	Primary	Preparatory	General Secondary	Vocational Secondary	Post-Secondary Institutes	University & Above	Total
Job Requires Skill	27.8	45.0	43.6	39.3	27.6	39.8	40.7	44.0	38.8
Skill Acquisition, Conditional on Having a Job that Requires a Skill									
Regular School (Except Vocational Education)	0.2	0.2	1.3	2.5	14.1	6.6	17.6	69.5	17.6
Vocational Education	0.9	0.7	1.3	2.0	4.3	18.2	35.0	2.9	8.6
Vocational Training	3.3	3.4	6.2	5.0	5.3	5.7	4.9	1.5	4.4
Through Contractor	9.3	6.0	5.3	4.8	0.0	4.6	2.7	0.6	4.4
Through Craftsman	63.2	63.4	64.7	62.4	49.9	40.1	21.7	6.2	42.2
On the Job	20.7	21.7	18.3	20.4	26.0	22.4	17.6	17.3	20.3
Other	2.4	4.7	2.9	3.0	0.5	2.4	0.6	2.0	2.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Author's calculations using ELMPS 2012.

Table 2.4. Mean and Median Hourly Wages (in 2012 LE) by Educational Attainment, Male Wage Workers, Ages 15-64

	Mean	Median
Illiterate	4.78	3.89
Reads & Writes	5.30	3.85
Primary	5.45	4.00
Preparatory	4.87	4.12
General Secondary	5.76	4.40
Vocational Secondary	5.77	4.40
Post-Secondary Inst.	7.47	5.22
University & Above	9.89	6.59
Total	6.40	4.50

Source: Author's calculations using ELMPS 2012.

Table 2.5. OLS Linear and Level Estimates of Returns to Education, Male Wage Workers

Dependent Variable: ln(hourly wage).

Specification:	**Spec. 1**	**Spec. 2**	**Spec. 3**	**Spec. 4**	**Spec. 5**	**Spec. 6**
Ages:	**15-64**	**15-34**	**35-64**	**15-64**	**15-34**	**35-64**
Years of School	0.041***	0.022***	0.053***			
	(0.002)	(0.002)	(0.002)			
Education Level (Illiterate/R&W Omitted)						
Primary				0.035	-0.046	0.059
				(0.027)	(0.032)	(0.047)
Preparatory				0.072**	-0.028	0.119**
				(0.030)	(0.040)	(0.047)
Voc. Sec.				0.217***	0.031	0.404***
				(0.021)	(0.027)	(0.032)
Gen. Sec.				0.236***	0.116**	0.274***
				(0.045)	(0.056)	(0.076)
Higher Ed.				0.565***	0.326***	0.763***
				(0.024)	(0.035)	(0.036)
Work Experience (Yrs.)	0.023***	0.034***	0.001	-0.002	0.021**	0.001
	(0.002)	(0.006)	(0.005)	(0.005)	(0.010)	(0.005)
Work Experience (Yrs.) Sq./100	-0.024***	-0.107***	0.017*	0.015	-0.082**	0.003
	(0.005)	(0.025)	(0.010)	(0.012)	(0.040)	(0.010)
Constant	0.835***	0.997***	1.009***	1.122***	1.193***	1.580***
	(0.026)	(0.040)	(0.071)	(0.038)	(0.049)	(0.086)
Region	No	No	No	Yes	Yes	Yes
5-year Labor Market Entry Cohorts	No	No	No	Yes	Yes	Yes
Observations	8369	4738	3631	8371	4741	3630
Adjusted R-sq.	0.093	0.023	0.117	0.124	0.054	0.151

Notes: *p<0.1 **p<0.05 ***p<0.01

Robust (Huber/White) standard errors in parentheses.

Source: Author's calculations using ELMPS 2012.

Table 2.6. OLS Level Estimates of Returns to Education by Sector, Male Wage Workers

Dependent Variable: ln(hourly wage).

Ages:	15-64		15-34		35-64	
Sector:	Public	Private	Public	Private	Public	Private
Education Level (Illiterate/R&W Omitted)						
Primary	0.161**	-0.003	-0.142	-0.033	0.210**	0.013
	(0.075)	(0.029)	(0.178)	(0.033)	(0.082)	(0.058)
Preparatory	0.318***	0.007	-0.100	-0.018	0.368***	-0.019
	(0.077)	(0.033)	(0.204)	(0.041)	(0.084)	(0.056)
Voc. Sec.	0.585***	0.103***	0.029	0.056**	0.693***	0.117**
	(0.053)	(0.024)	(0.130)	(0.028)	(0.059)	(0.049)
Gen. Sec.	0.554***	0.148***	0.338*	0.096	0.432***	0.213*
	(0.097)	(0.052)	(0.187)	(0.059)	(0.111)	(0.110)
Higher Ed.	0.968***	0.383***	0.467***	0.294***	1.016***	0.488***
	(0.054)	(0.035)	(0.132)	(0.041)	(0.061)	(0.071)
Work Experience (Yrs.)	-0.018**	0.008	-0.009	0.025**	-0.020**	-0.003
	(0.008)	(0.006)	(0.025)	(0.010)	(0.009)	(0.012)
Work Experience (Yrs.) Sq./100	0.052***	-0.016	0.005	-0.093**	0.055***	0.006
	(0.018)	(0.015)	(0.117)	(0.041)	(0.020)	(0.025)
Constant	0.826***	1.218***	1.267***	1.171***	1.595***	1.536***
	(0.089)	(0.045)	(0.160)	(0.053)	(0.493)	(0.251)
Region	Yes	Yes	Yes	Yes	Yes	Yes
5-year Labor Market Entry Cohorts	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2737	5634	826	3915	1911	1719
Adjusted R-sq.	0.204	0.061	0.136	0.040	0.208	0.075

Notes: *p<0.1 **p<0.05 ***p<0.01

Robust (Huber/White) standard errors in parentheses.

Source: Author's calculations using ELMPS 2012.

Table 2.7. OLS Level Estimates of Returns to Education and Skills, Male Wage Workers

Dependent Variable: ln(hourly wage).

Specification:	Spec. 7	Spec. 8	Spec. 9
Ages:	15-64	15-34	35-64
Education Level (Illiterate/R&W Omitted)			
Primary	0.028	-0.043	0.031
	(0.027)	(0.032)	(0.048)
Preparatory	0.064**	-0.017	0.051
	(0.031)	(0.040)	(0.048)
Voc. Sec.	0.149***	0.024	0.203***
	(0.022)	(0.028)	(0.041)
Gen. Sec.	0.151***	0.092	0.072
	(0.046)	(0.056)	(0.081)
Higher Ed.	0.294***	0.158***	0.360***
	(0.035)	(0.045)	(0.056)
Required Education Level (Illit./R&W Omitted)			
Requires Primary	-0.102***	-0.156***	0.003
	(0.036)	(0.043)	(0.061)
Requires Preparatory	-0.011	-0.133**	0.145*
	(0.049)	(0.058)	(0.076)
Requires Secondary	0.142***	0.047	0.250***
	(0.023)	(0.030)	(0.038)
Requires Higher Ed.	0.359***	0.278***	0.441***
	(0.033)	(0.045)	(0.050)
Requires Skill	0.102***	0.084***	0.108***
	(0.022)	(0.029)	(0.032)
Apprentice, Craft Trade	0.053	-0.095	0.397**
	(0.082)	(0.076)	(0.201)
Assistant, Craft Trade	-0.014	-0.016	-0.003
	(0.037)	(0.042)	(0.090)
Craftsman, Craft Trade	0.084***	0.114***	0.067
	(0.027)	(0.035)	(0.042)
Work Experience (Yrs.)	-0.001	0.021**	-0.011
	(0.005)	(0.010)	(0.007)
Work Experience (Yrs.) Sq./100	0.011	-0.082**	0.032**
	(0.012)	(0.039)	(0.016)
Constant	1.062***	1.126***	1.405***
	(0.039)	(0.049)	(0.222)
Region	Yes	Yes	Yes
5-year Labor Market Entry Cohorts	Yes	Yes	Yes
Observations	8371	4741	3630
Adjusted R-sq.	0.149	0.079	0.179

Notes: *p<0.1 **p<0.05 ***p<0.01

Robust (Huber/White) standard errors in parentheses.

Source: Author's calculations using ELMPS 2012.

Table 2.8. Family Fixed Effects OLS Estimates of Returns to Education and Skills, Male Wage Workers

Dependent Variable: ln(hourly wage).

Specification:	**Spec. 10**	**Spec. 11**	**Spec. 12**	**Spec. 13**	**Spec. 14**	**Spec. 15**
Ages:	**15-64**	**15-34**	**15-64**	**15-34**	**15-64**	**15-34**
Years of School	0.018***	0.007				
	(0.005)	(0.007)				
Education Level (Illiterate/R&W Omitted)						
Primary			0.054	-0.034	0.044	-0.043
			(0.057)	(0.062)	(0.056)	(0.061)
Preparatory			0.029	-0.083	0.023	-0.086
			(0.069)	(0.075)	(0.067)	(0.076)
Voc. Sec.			0.102*	0.039	0.081	0.014
			(0.055)	(0.061)	(0.054)	(0.061)
Gen. Sec.			0.100	0.040	0.067	-0.014
			(0.113)	(0.119)	(0.114)	(0.118)
Higher Ed.			0.267***	0.112	0.176**	0.050
			(0.074)	(0.091)	(0.082)	(0.092)
Required Education Level (Illit./R&W Omitted)						
Requires Primary					-0.198**	-0.194*
					(0.086)	(0.100)
Requires Preparatory					0.010	0.085
					(0.138)	(0.144)
Requires Secondary					0.066	0.154**
					(0.064)	(0.076)
Requires Higher Ed.					0.211**	0.193*
					(0.093)	(0.116)
Requires Skill					-0.030	-0.083
					(0.068)	(0.092)
Apprentice, Craft Trade					0.083	-0.155
					(0.310)	(0.174)
Assistant, Craft Trade					0.094	0.073
					(0.091)	(0.114)
Craftsman, Craft Trade					0.177**	0.203**
					(0.072)	(0.095)
Work Experience (Yrs.)	0.022***	0.030***	-0.004	0.031*	-0.006	0.027
	(0.007)	(0.011)	(0.015)	(0.019)	(0.015)	(0.019)
Work Experience (Yrs.) Sq./100	-0.035	-0.106**	0.034	-0.155*	0.041	-0.138
	(0.021)	(0.046)	(0.048)	(0.085)	(0.045)	(0.086)
Constant	1.066***	1.169***	1.039***	1.181***	1.026***	1.164***
	(0.078)	(0.083)	(0.187)	(0.286)	(0.183)	(0.290)
Region	No	No	Yes	Yes	Yes	Yes
5-year Labor Market Entry Cohorts	No	No	Yes	Yes	Yes	Yes

Specification:	**Spec. 10**	**Spec. 11**	**Spec. 12**	**Spec. 13**	**Spec. 14**	**Spec. 15**
Ages:	**15-64**	**15-34**	**15-64**	**15-34**	**15-64**	**15-34**
Observations	2298	1650	2300	1652	2300	1652
Groups	955	706	955	706	955	706
Adjusted R-sq.	0.018	0.007	0.032	0.022	0.044	0.037

Notes: *p<0.1 **p<0.05 ***p<0.01

Robust (Huber/White) standard errors in parentheses.

Source: Author's calculations using ELMPS 2012.

Table 2.9. Occupations and Jobs Requiring No Education, Employed Males, Ages 15-64

Occupation	Percentage Req. No Education	Percentage of Workers	N (Obs.)
Legislators and Senior Officials	(-)	(-)	5
Corporate Managers	43.9	7.9	896
General Managers	3.6	0.4	35
Physical, Mathematical, and Engineering Science Professions	1.1	1.6	152
Life Science and Health Professionals	1.3	0.8	100
Teaching Professionals	0.3	4.3	501
Other Professionals	1.2	4.4	500
Physical and Engineering Science Associate Professionals	13.9	3.3	321
Life Science and Health Associate Professionals	5.0	0.7	88
Teaching Associate Professionals	(-)	(-)	4
Other Associate Professionals	13.9	3.9	434
Office Clerks	6.4	1.7	187
Customer Service Clerks	6.0	0.7	78
Personal and Protective Services Workers	49.6	5.0	566
Models, Salespersons, and Demonstrators	50.9	6.8	795
Market-Oriented Skilled Agricultural and Fishery Workers	95.1	18.1	2,188
Extraction and Building Trades Workers	88.2	12.7	1,514
Metal, Machinery, and Related Trades Workers	66.7	3.6	402
Precision Handicraft, Printing, and Related Trades	66.4	1.0	89
Wood Treaters, Cabinet Makers, Related Trades	81.1	3.8	419
Stationary-Plant and Related Operators	17.8	0.5	65
Machine Operators and Assemblers	45.5	2.7	285
Drivers and Mobile-Plant Operators	45.0	8.7	946
Sales and Services Elementary Occupations	58.3	7.2	794
Agricultural, Fishery, and Related Laborers	(-)	(-)	1
Mining and Construction Laborers	88.2	0.3	37
Total	54.9	100.0	11,402

Notes: (-) indicates a suppressed cell with <30 respondents. Occupations are classified on the two-digit level using ISCO 88 coding.
Source: Author's calculations using ELMPS 2012.

Table 2.10. Economic Activities and Jobs Requiring No Education, Employed Males, Ages 15-64

Economic Activity	Percentage Req. No Education	Percentage of Workers	N (Obs.)
Agriculture, Forestry and Fishing	94.8	18.3	2,222
Mining and Quarrying	61.3	0.3	32
Manufacturing	51.6	14.8	1,559
Electricity, Gas, Steam and Air Conditioning Supply	9.8	0.9	103
Water Supply; Sewage, Waste Management and Remediation Activities	29.5	1.1	111
Construction	81.3	13.8	1,595
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	56.4	14.8	1,706
Transportation and Storage	43.2	8.9	993
Accommodation and Food Service Activities	58.4	3.2	359
Information and Communication	9.0	1.2	140
Financial and Insurance Activities	4.9	0.9	102
Real Estate Activities	(-)	(-)	7
Professional, Scientific and Technical Activities	1.7	1.8	175
Administrative and Support Service Activities	22.0	1.0	94
Public Administration and Defense; Compulsory Social Security	15.0	7.3	860
Education	7.9	6.5	739
Human Health and Social Work Activities	12.0	1.7	197
Arts, Entertainment and Recreation	30.2	0.6	65
Other Service Activities	54.0	2.7	314
Activities of Extraterritorial Organizations and Bodies	(-)	(-)	29
Total	54.9	100.0	11,402

Notes: (-) indicates a suppressed cell with <30 respondents. Economic activities are classified on the one digit level using ISIC 4 coding.
Source: Author's calculations using ELMPS 2012.

Table 2.11. Occupations and Jobs Requiring Skills, Employed Males, Ages 15-64

Occupation	Percentage Skilled	Percentage of Workers	N (Obs.)
Legislators and Senior Officials	(-)	(-)	5
Corporate Managers	32.0	7.9	896
General Managers	29.0	0.4	35
Physical Mathematical and Engineering Science Professions	77.9	1.6	152
Life Science and Health Professionals	66.0	0.8	100
Teaching Professionals	47.3	4.3	501
Other Professionals	38.6	4.4	500
Physical and Engineering Science Associate Professionals	71.4	3.3	321
Life Science and Health Associate Professionals	49.0	0.7	88
Teaching Associate Professionals	(-)	(-)	4
Other Associate Professionals	29.3	3.9	434
Office Clerks	24.2	1.7	187
Customer Service Clerks	29.6	0.7	78
Personal and Protective Services Workers	30.2	5.0	566
Models Salespersons and Demonstrators	13.0	6.8	795
Market-Oriented Skilled Agricultural and Fishery Workers	11.2	18.1	2,188
Extraction and Building Trades Workers	59.6	12.7	1,514
Metal Machinery and Related Trades Workers	86.5	3.6	402
Precision Handicraft Printing and Related Trades	54.9	1.0	89
Wood Treaters Cabinet Makers Related Trades	74.7	3.8	419
Stationary-Plant and Related Operators	51.7	0.5	65
Machine Operators and Assemblers	61.4	2.7	285
Drivers and Mobile-Plant Operators	59.3	8.7	946
Sales and Services Elementary Occupations	7.6	7.2	794
Agricultural, Fishery, and Related Laborers	(-)	(-)	1
Mining and Construction Laborers	12.6	0.3	37
Total	38.7	100.0	11,402

Notes: (-) indicates a suppressed cell with <30 respondents. Occupations are classified on the two-digit level using ISCO 88 coding.
Source: Author's calculations using ELMPS 2012.

Table 2.12. Economic Activities and Jobs Requiring Skills, Employed Males, Ages 15-64

Economic Activity	Percentage Skilled	Percentage of Workers	N (Obs.)
Agriculture, Forestry and Fishing	11.8	18.3	2,222
Mining and Quarrying	39.0	0.3	32
Manufacturing	63.7	14.8	1,559
Electricity, Gas, Steam and Air Conditioning Supply	56.8	0.9	103
Water Supply; Sewage, Waste Management and Remediation Activities	41.4	1.1	111
Construction	57.2	13.8	1,595
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	24.4	14.8	1,706
Transportation and Storage	52.2	8.9	993
Accommodation and Food Service Activities	24.8	3.2	359
Information and Communication	51.7	1.2	140
Financial and Insurance Activities	34.8	0.9	102
Real Estate Activities	(-)	(-)	7
Professional, Scientific and Technical Activities	58.6	1.8	175
Administrative and Support Service Activities	31.4	1.0	94
Public Administration and Defense; Compulsory Social Security	30.0	7.3	860
Education	37.2	6.5	739
Human Health and Social Work Activities	36.1	1.7	197
Arts, Entertainment and Recreation	47.3	0.6	65
Other Service Activities	47.7	2.7	314
Activities of Extraterritorial Organizations and Bodies	(-)	(-)	29
Total	38.7	100.0	11,402

Notes: (-) indicates a suppressed cell with <30 respondents. Economic activities are classified on the one digit level using ISIC 4 coding.
Source: Author’s calculations using ELMPS 2012.

Chapter 3

3 Why is Fertility on the Rise in Egypt? The Role of Women's Employment Opportunities

3.1 Introduction

The demographic transition—the shift from a high mortality, high fertility pattern to low mortality, greater life expectancy, and lower (replacement) fertility—leads to dramatic changes in the structure of societies and economies. The period prior to and during the transition, characterized by rapid population growth, presents a particular challenge. Rapid population growth tends to place serious pressure on public services, natural resources, and the labor market, but the demographic transition can also provide a "demographic dividend" to accelerate growth and generate a variety of other benefits for society (Canning & Schultz, 2012; Reher, 2011). Thus, the pattern and progress of a country's demographic transition has critical implications for its economy and society.

The determinants of the demographic transition generally, and fertility in particular, are complex. As well as the relatively obvious health and demographic factors that affect fertility, social and economic forces also shape fertility (Schultz, 1969). Past research has primarily focused on how different factors could speed or stall the fertility transition (Bongaarts, 2006). This essay demonstrates that the fertility transition has not just stalled but in fact has started reversing in Egypt, where fertility rates have risen. Although a number of different factors are likely to be contributing to the rise in fertility, this essay specifically tests whether the changing landscape of employment opportunities for women, namely the decline of the public sector as an employer, has contributed to rising fertility.

Evidence in Egypt indicated that, despite some stalls, overall fertility had been declining through 2008 (Bongaarts, 2008; El-Zanaty & Way, 2009). The most recent evidence, however, indicates that the crude birth rate has been rising in Egypt, from a low of 26 (births per thousand people) in 2003-2006 to a high of 32 in 2012 (Central Agency for Public Mobilization and Statistics, 2015). These rising birth rates could be due to an increase in fertility or to the changing age structure of the population. Egypt has a substantial youth bulge, and as of 2012 the peak of the youth bulge was in the 25-29 age range (Assaad & Krafft, 2015a), the prime childbearing age. This essay demonstrates that the rising tide of births is because fertility has increased in Egypt.

Rising fertility in Egypt has coincided with substantial changes in the structure of the economy, and in particular changes in the types of employment available. The share of employment in the public sector has declined substantially, while informal private sector employment has increased. Informal and private sector employment opportunities are substantially less appealing and available to women than public sector jobs (Nassar, 2003). In part due to the changing structure of the economy, the female employment rate has decreased in recent years. This decline in female employment is particularly surprising given that factors associated with higher female labor force participation, such as female education, have been increasing (Assaad & Krafft, 2015a, 2015c).

That changes in the structure of employment may have increased fertility is consistent with economic theories that recognize that one of the costs of children is an opportunity cost—the value of parents' time. If, for women, employment opportunities decrease, then the relative cost of childbearing will decrease, potentially increasing fertility. However, at the same time household income will fall, and the net effect of these income and price effects is theoretically ambiguous (Becker, 1960; Schultz, 1997). The global evidence to date on the impact of employment on fertility is primarily focused on rising relative wages increasing women's employment and decreasing fertility (Galor & Weil, 1996; Heckman & Walker, 1990; Schultz, 1985). There are also a few studies directly examining the impact of increasing employment opportunities for women on their fertility (Fang, Eggleston, Rizzo, & Zeckhauser, 2013; Jensen, 2012). However, papers on employment opportunities have addressed fertility behaviors primarily for young women, not lifetime fertility. In contrast, this essay estimates the impact of economic opportunities for women on the timing and occurrence of births over the full range of women's childbearing years, demonstrating how economic opportunities have contributed to the recent rise in fertility.

This essay investigates, for the case of Egypt, both how the fertility rate has evolved over time and how childbearing responds to women's economic opportunities, specifically public sector employment. The essay proceeds as follows: Section 2 reviews the theoretical and empirical evidence on fertility and work. Section 3 presents the conceptual model for understanding how work opportunities may impact fertility. Section 4 discusses the methods required to estimate fertility and its relationship with employment. Section 5 describes the data used to estimate the relationship between fertility and employment opportunities. Section 6 shows the descriptive results, in terms of patterns of fertility and related phenomena. Section 7 presents the estimated hazard models for the relationship between fertility and employment opportunities. Discussion and conclusions are provided in section 8.

3.2 Theories and Evidence on Fertility and Work

3.2.1 Demographic Transition Theories

Demographic transition theories provide the over-arching framework for understanding long-term trends in fertility and their relationship with social and economic forces. Demographic transition theories specifically provide insight into the link between declines in fertility and increases in female labor force participation (Bloom, Canning, Fink, & Finlay, 2009; Canning & Schultz, 2012; Kim, 2010; Kirk, 1996). The forces that bring about fertility declines and subsequent increases in female labor force participation can be broadly dubbed "modernization," an umbrella term that has been associated with a variety of factors, including improvements in health and decreases in mortality, changing norms and values, and a changing economic landscape. Increases in (female) education may play a key role in modernizing changes, due to education's links with wages (returns to education), work, and contraceptive use. Essentially, "modern" economic arrangements lead to increases in female labor force participation and reductions in childbearing.

The relationship between fertility and female labor force participation that is usually posited is that rising economic opportunities for women can cause decreases in fertility. This essay investigates an alternative form of this relationship—whether declining opportunities for women in Egypt increased fertility. While demographic transition theories recognize that socio-economic changes raise the costs and decrease the benefits of children, and theorize that this relationship drives declines in fertility (Bongaarts, 2006), these theories have limited insight into stalls in fertility declines (Bongaarts, 2006, 2008) and have not taken up potential reversals in fertility trends.

3.2.2 The Economics of Fertility

Early economic theories of fertility can be called the “new home economics” (Kirk, 1996), a school of thought led by Becker (1960) and Schultz (1973), which extended traditional economic theories of consumer choice to institutions such as the family. In this basic framework for the economics of fertility, a household (married couple) decides how many children to have by solving a utility maximization problem into which children enter as a source of utility (Becker, 1960; Willis, 1973). As well as being sources of satisfaction, children have a cost in terms of time and money. The cost of the child is characterized as a function of (the mother’s) time,[49] as well as more explicit costs (Schultz, 1973; Willis, 1973). These costs have implications in terms of the allocation of women’s time. If the cost of a mother’s time increases (i.e. women’s wages increase), there may be a decrease in the number of children. This relationship is the main mechanism through which women’s economic opportunities can impact fertility, particularly in societies, like Egypt, where the household division of labor allocates child-rearing responsibilities to women (Hoodfar, 1997).

Early formulations of the economics of fertility suffered from a variety of problems. They tended to be static models and did not incorporate uncertainty (Schultz, 1973; Willis, 1973). Additionally, they relied heavily on the unitary household model, where individual members’ utility could be readily aggregated, perhaps because an

[49] An implicit assumption in such theories is that women are responsible for child care.

altruistic household head maximizes the household's utility (Willis, 1973). The unitary household model's assumptions are questionable (Birdsall, 1988) and have not held up to empirical scrutiny (Udry, 1996). As an alternative, models that allow for bargaining between spouses over fertility decisions show substantial promise (Rasul, 2008). Although theoretical approaches to the economics of fertility vary, it is difficult to dispute that there is an opportunity cost, in terms of women's time, of raising children.

3.2.3 Empirical Evidence on Fertility and Work

The empirical literature from both developed (Angrist & Evans, 1998; Jacobsen, Pearce, & Rosenbloom, 1999) and developing countries (Cáceres-Delpiano, 2012; Cruces & Galiani, 2007) provides substantial evidence that fertility impacts female employment. These studies make convincing causal arguments for fertility shocks affecting female employment based on instrumental variables methods, identifying the effect of fertility based on exogenous variation in child sex (Angrist & Evans, 1998; Cruces & Galiani, 2007), or the occurrence of multiple births (Cáceres-Delpiano, 2012; Jacobsen, Pearce, & Rosenbloom, 1999).

While the focus in the empirical literature has been on the impact of fertility on employment, there have also been investigations into reverse causality or interdependence. Lloyd (1991) recognizes the interdependence of women's work and fertility, and argues that the expansion of work opportunities for women can decrease their fertility. A substantial challenge, which Lloyd does not overcome, is identifying a causal impact from work to fertility. This challenge has long plagued even developed country research (Cramer, 1980). There are convenient instruments for fertility, such as child sex and multiple births, but there are not as many easily identifiable sources of exogenous variation in employment. A more popular alternative than studying the impact of employment on fertility is studying the impact of education on fertility, a relationship that is also often linked to work. In general, increases in (women's) education have been linked to decreases in fertility (Angeles, Guilkey, & Mroz, 2005; Bledsoe, Casterline, Johnson-Kuhn, & Haaga, 1999; Lavy & Zablotsky, 2015; Osili & Long, 2008), but there are exceptions (Bledsoe, Casterline, Johnson-Kuhn, & Haaga, 1999; McCrary & Royer, 2011).

The papers that do attempt to estimate the causal relationship between women's work and fertility suggest that women's employment decreases fertility. Fang et al. (2013) use the availability of bus stops as an instrument for women's (endogenous) current employment and its impact on fertility to date in China. They find that employment decreases fertility to date by 0.5 births. However, when they sub-divide their sample into those who are unlikely to have more children and those who may still have additional children, the reduction in fertility drops to 0.17 for younger women and there is no effect on fertility for women who are unlikely to have more children, effectively no effect on completed childbearing. That their original result disappears when they sub-divide their sample casts substantial doubt on their initial result and their identification strategy.

Jensen (2012) solves the identification problem with an experiment, randomly providing employment recruiting services to young women (15-21) in villages in rural India. After three years, young women in treatment villages were more likely to be employed, were 5-6 percentage points less likely to be married or have children, and expressed, on average, a desire for 0.35 fewer children. Due to the short time span of the study, it is unknown whether delays in marriage, decreased early childbearing, and lower desired fertility will translate into decreases in completed fertility.

One key strand of the literature linking women's employment and fertility theorizes that it is changes in women's wages (relative to men's) that increase their employment and thus decrease fertility, potentially due to changes in the technology of production (Galor & Weil, 1996; Schultz, 1997). Schultz (1985) empirically demonstrates how wages might affect fertility based on increases in the price of butter relative to grains in the 1880s in Sweden, which changed the relative wages of women, since dairy processing was women's work. This increase in the value of women's time (relative to men's) is shown to be responsible for a quarter of the decline in fertility over several decades in Sweden. Similar relationships have been found for a more recent study in Sweden, as well as examinations of Thailand and India (Heckman & Walker, 1990; Mukhopadhyay, 1994; Rosenzweig & Evenson, 1977). However, there continue to be debates about the (female) income and fertility relationship and whether the results are robust. One strand of the literature discusses whether, after a certain point, rising female wages might increase fertility (Ahn & Mira, 2002; Kögel, 2004; Martínez & Iza, 2004). Overall, the evidence indicates that increases in the value of women's time will probably, but not definitely, decrease fertility. The reverse case, when the market value of women's time declines, to the best of the author's knowledge, has not been examined.

3.2.4 Division of Labor, Employment, and Childbearing in Egypt

The sexual division of labor within Egyptian households is such that men's roles are limited to providing for the family (Hoodfar, 1997), i.e. their primary responsibility is engaging in some type of employment. In contrast, women's primary responsibilities are attending to husband, children, and home. Women can work outside the home only if their domestic responsibilities can be performed at least as well—if not better—when combined with market work (Hoodfar, 1997). There is no decrease in married women's hours of domestic work (carework) if they also engage in market-based employment (Assaad & Krafft, 2014). So while women in Egypt can mix employment and child-production roles, the tradeoffs in doing so vary substantially by the nature of their work and its compatibility with domestic roles.

Public sector jobs are much easier to reconcile with marriage and childbearing than private sector employment. Married women with children are more likely to report that they worked during their last pregnancy if they were working for a wage in the public sector (79%) compared to the private formal sector (64%) or private informal sector (46%). One reason for this disparity across sectors is the substantially more generous maternity benefits for public wage workers. Among women working during their last pregnancy, 86% of those in public sector wage work had a six-week or longer paid maternity leave, in comparison with 47% of private formal wage workers and just 12% of private informal wage workers (Assaad & El-Hamidi, 2009). Women working in the government can also take up to two years of unpaid leave for each of their first three children, above and beyond their paid maternity leave (Hoodfar, 1997). In part due to the substantially different nature and benefits of public sector jobs, qualitative and quantitative studies demonstrate that there is a strong preference for public sector jobs in Egypt. Young women particularly value public sector benefits such as increased job security and pensions, as well as the shorter hours and lighter workload associated with public sector employment (Barsoum, 2015).

Structural adjustment programs and economic reforms have changed the employment opportunities available to women in Egypt. A key element of the initial structural adjustment program in 1987 was the reduction of the government wage bill (Nassar, 2003). Additionally, starting in the 1980s, there was a phase-out of a policy that had begun in the 1960s, when the government had guaranteed public sector jobs to all secondary and higher education graduates. This policy was no longer in effect as of the end of the 1990s. Since 1980, public sector hiring has declined. Substantial decreases in labor force participation rates for educated women have followed these reforms. Women who participate in the labor force are often unemployed, engaging in queuing behaviors whereby they register with the government as job-seeking in hopes of being appointed to a government job, but neither seek nor would accept a private sector job (Assaad & Krafft, 2015a; Assaad, 1997a).

Women were and continue to be disproportionately dependent on the public sector for employment, with more than half (52%) of employed women working in the public sector in 2012, in contrast to just less than a quarter (24%) of employed men (Assaad & Krafft, 2015c). Rather than shifting to employment in the private sector, in the face of declines in public sector employment, women, especially educated women, have withdrawn from the labor force. Olmsted (2003) wondered whether the structural adjustment programs in Egypt, because they substantially reduced employment opportunities for women and the opportunity costs of having children, might cause stagnation or even an increase in fertility rates. This essay investigates that very question, looking at the impact of changing employment opportunities on fertility in Egypt.

3.3 Conceptual Framework

This essay models fertility as the outcome of a child production function and a household utility maximization problem, as have many others before (Becker, 1960; Birdsall, 1988; Schultz, 1997; Willis, 1973). Since decisions over fertility are likely to be made at the household level, this essay uses a unitary household model for simplicity. Specifically, the model of Schultz (1997) for the demand for children is modified for the context at hand. A couple's lifetime household utility, *U*, is a function of the number of children, *C*, the education and health of children, *E* and *H*, the leisure of the husband, L_h, and the wife, L_w, as well as a composite household consumption good, *G:*

$$U(C, E, H, L_h, L_w, G) \tag{3.1}$$

Utility is assumed to be increasing in all these arguments. The goods in the utility function, namely *C*, *E*, *H*, and *G*, denoted generically as *S*, are produced through some constant returns to scale technology using market goods, *X*, and the time the husband and wife spend in production, T_{hS} and T_{wS}:

$$S = f_S(X_S, T_{hS}, T_{wS}, \mu_S) \tag{3.2}$$

for *S* = *C, E, H, G.* The term μ_S is couple specific productivity that is known but not controlled by the couple. For the output of children this term can be thought of as fecundity.

Individuals face a time constraint across market work (subscripted *m*), production work, and leisure:

$$\Omega_j = T_{jm} + \sum_S T_{jS} + L_j \tag{3.3}$$

where Ω_j denotes the time budget constraint for *j* = *h*, *w* and *S* = *C, E, H, G.* The household's market income, *Y*, is based on its members' wages, W_j, and their market labor supply:

$$Y = T_{hm}W_h + T_{wm}W_w \tag{3.4}$$

Under certain assumptions, or as a helpful heuristic, full income, *F*, can also be derived as:

$$F = \Omega_h W_h + \Omega_w W_w \tag{3.5}$$

The household's utility maximization problem is therefore to choose *C, E, H,* L_h, L_w, *G* to:

$$\text{Max } U(C, E, H, L_h, L_w, G) \tag{3.6}$$

$$\text{subject to (i) } T_{hm} W_h + T_{wm} W_w = Y = PX$$

$$\text{(ii) } S = f_S(X_S, T_{hS}, T_{wS}, \mu_S)$$

$$\text{for } S = C, E, H, G$$

$$\text{and (iii) } \Omega_j = T_{jm} + \textstyle\sum_S T_{jS} + L_j$$

$$\text{for } j = h, w$$

where *P* is the price of market goods. While utility is increasing in *C, E, H,* L_h, L_w, and *G*, there are tradeoffs between these goods, as mediated through the constraints.

The tradeoffs facing women considering different jobs are not solely captured by the market wage rate. Women's wages are at parity with men's in the public sector but there is a wage gap in the private sector (Said, 2015). Commute time and child care responsibilities are major considerations that are going to be weighed against wages, particularly for women (Assaad & Arntz, 2005; Hoodfar, 1997). As mentioned above, there are also non-wage benefits to jobs, which tend to be substantial in the public sector (Assaad, 1999; Barsoum, 2015). Rather than having reservation wages, women may also have reservation working conditions in terms of reputation (Dougherty, 2014; Groh, McKenzie, Shammout, & Vishwanath, 2014).

Additionally, only some types of jobs (such as self-employment or family employment) allow for a continuous division of time. Wage jobs tend to have fixed hours of work that are closely related to the type of work, especially public sector versus private sector (Assaad & Krafft, 2015c; Hoodfar, 1997). Ultimately, women's choice of market labor supply, T_{wm}, is going to take all of these factors into account. For modeling simplicity, assume that all of these different factors can be monetized into what is now the effective wage rate facing women, W_w. Since for women both the wage and non-wage benefits of public sector jobs are greater than private sector jobs, a decrease in government employment is essentially a decrease in W_w or in expected W_w.

Consider now the issue of how changes in this broad concept of W_w, for instance decreases in public sector employment decreasing “wages,” might affect childbearing. Start with a case that simplifies the above model to allow only tradeoffs in terms of child quantity, *C*, versus the composite consumption good, *G*. Assuming an interior solution and given the assumption of a constant returns to scale production function for both the goods, utility will be maximized when the marginal rate of substitution equals the relative prices for *C* and *G* (Ben-Porath, 1974):

$$\frac{\partial U/\partial C}{\partial U/\partial G} = \frac{\frac{T_{wC}W_w + T_{hC}W_h + PX_C}{C}}{\frac{T_{wG}W_w + T_{hG}W_h + PX_G}{G}} = \frac{\pi_C}{\pi_G} \tag{3.7}$$

where π_S is hereafter shorthand for the full (shadow) price of a unit of good *S* (*C* or *G*). With this notation, demand for children can then be denoted in price and (full) income terms as $C(\pi_C, \pi_G, F)$.

Let there be a change in the availability of public sector jobs, denoted by *B,* which affects women’s wages, W_w. To determine how the change in public sector employment affects childbearing define both full price effects:

$$\frac{\partial \pi_C}{\partial B} = \frac{\partial W_w}{\partial B} * \frac{T_{wC}}{C} \tag{3.8}$$

$$\frac{\partial \pi_G}{\partial B} = \frac{\partial W_w}{\partial B} * \frac{T_{wG}}{G}$$

and a full income effect:

$$\frac{\partial F}{\partial B} = \frac{\partial W_w}{\partial B}\Omega_w \tag{3.9}$$

The impact of changing *B* on fertility is then:

$$\frac{\partial C}{\partial B} = \frac{\partial C}{\partial \pi_C} * \frac{\partial \pi_C}{\partial B} + \frac{\partial C}{\partial \pi_G} * \frac{\partial \pi_G}{\partial B} + \frac{\partial C}{\partial F} * \frac{\partial F}{\partial B} \tag{3.10}$$

$$\frac{\partial C}{\partial B} = \frac{\partial W_w}{\partial B}\left(\frac{\partial C}{\partial \pi_C} * \frac{T_{wC}}{C} + \frac{\partial C}{\partial \pi_G} * \frac{T_{wG}}{G} + \frac{\partial C}{\partial F} * \Omega_w\right)$$

To sign all the terms it is helpful to, first, decompose the price effects into compensated price effects and income effects, where compensated price effects are denoted by the symbol ° below. Recall that by the Slutsky equation we know:

$$\frac{\partial C}{\partial \pi_C} = \frac{\partial C^{\circ}}{\partial \pi_c} - C\frac{\partial C}{\partial F} \tag{3.11}$$

$$\frac{\partial C}{\partial \pi_G} = \frac{\partial C^{\circ}}{\partial \pi_G} - G\frac{\partial C}{\partial F}$$

As a result, (3.10) becomes:

$$\frac{\partial C}{\partial B} = \frac{\partial W_w}{\partial B}\left(\frac{\partial C^{\circ}}{\partial \pi_c} * \frac{T_{wC}}{C} - C\frac{\partial C}{\partial F} * \frac{T_{wC}}{C} + \frac{\partial C^{\circ}}{\partial \pi_G} * \frac{T_{wG}}{G} - G\frac{\partial C}{\partial F} * \frac{T_{wG}}{G} + \frac{\partial C}{\partial F} * \Omega_w\right) \tag{3.12}$$

$$\frac{\partial C}{\partial B} = \frac{\partial W_w}{\partial B}\left(\frac{\partial C^{\circ}}{\partial \pi_c} * \frac{T_{wC}}{C} + \frac{\partial C^{\circ}}{\partial \pi_G} * \frac{T_{wG}}{G} + \frac{\partial C}{\partial F}(\Omega_w - T_{wC} - T_{wG})\right)$$

An important fact to keep in mind in is that, since compensated demand is homogenous of degree zero in prices, by Euler's formula:

$$\pi_G * \frac{\partial C^{\circ}}{\partial \pi_G} + \pi_C * \frac{\partial C^{\circ}}{\partial \pi_C} = 0 \tag{3.13}$$

$$\frac{\partial C^{\circ}}{\partial \pi_G} = -\frac{\pi_C}{\pi_G} * \frac{\partial C^{\circ}}{\partial \pi_C}$$

Substituting (3.13) into (3.12) yields:

$$\frac{\partial C}{\partial B} = \frac{\partial W_w}{\partial B}\left(\frac{\partial C^{\circ}}{\partial \pi_c} * \frac{T_{wC}}{C} - \frac{\pi_C}{\pi_G} * \frac{\partial C^{\circ}}{\partial \pi_C} * \frac{T_{wG}}{G} + \frac{\partial C}{\partial F} * T_{wm}\right) \tag{3.14}$$

This equation can be transformed into elasticity terms in a series of steps as follows. First, multiply both sides by $\frac{B}{C}$ and the right hand side by $\frac{W_w}{W_w}$:

$$\frac{\partial C/C}{\partial B/B} = \frac{\partial W_w/W_w}{\partial B/B}\left(\frac{\partial C^{\circ}/C}{\partial \pi_c} * \frac{T_{wC}}{C} * W_w - \frac{\pi_C}{\pi_G} * \frac{\partial C^{\circ}/C}{\partial \pi_C} * \frac{T_{wG}}{G} * W_w + \frac{\partial C/C}{\partial F} * T_{wm} * W_w\right) \tag{3.15}$$

With further manipulation this becomes:

$$\frac{\partial C/C}{\partial B/B} = \frac{\partial W_w/W_w}{\partial B/B}\left(\frac{\partial C^{\circ}/C}{\partial \pi_C/\pi_C} * \frac{W_w}{\pi_C} * \frac{T_{wC}}{C} - \frac{\partial C^{\circ}/C}{\partial \pi_C/\pi_C} * \frac{W_w}{\pi_G} * \frac{T_{wG}}{G} + \frac{\partial C/C}{\partial F/F}\left(\frac{T_{wm} * W_w}{F}\right)\right) \tag{3.16}$$

which can be denoted in elasticities (an elasticity is denoted by η) after gathering together terms as:

$$\eta_{CB} = \eta_{W_wB}\left(\eta_{C^{\circ}\pi_C}\left(\frac{W_w}{\pi_C} * \frac{T_{wC}}{C} - \frac{W_w}{\pi_G} * \frac{T_{wG}}{G}\right) + \eta_{CF}\left(\frac{T_{wm}W_w}{F}\right)\right) \tag{3.17}$$

It is now possible to define the elasticity of interest, η_{CB}, the (percentage) change in childbearing resulting from a (percentage) change in public sector job opportunities. The predictions of the model in terms of how households' fertility (C) responds to changes in job opportunities are ambiguous. In (3.17), η_{W_wB} denotes how women's wages change as public sector employment opportunities change, which we can readily sign as positive. Then the question is the sign of the term within the first set of parentheses. Since children are considered a normal good ($\eta_{CF} > 0$), there is a positive income effect in terms of the number of children.

Since the compensated price elasticity must be negative ($\eta_{C°\pi_C}$<0), a key question for the price effect is then in regards to the relative time intensity of children and other goods. It is generally assumed that children are more time intensive for women than other goods (Galor & Weil, 1996; Willis, 1973), i.e.:

$$\frac{W_w}{\pi_C} * \frac{T_{wC}}{C} > \frac{W_w}{\pi_G} * \frac{T_{wG}}{G} \tag{3.18}$$

$$\frac{T_{wC}W_w}{T_{wC}W_w + T_{hC}W_h + PX_C} > \frac{T_{wG}W_w}{T_{wG}W_w + T_{hG}W_h + PX_G}$$

Under this assumption, once multiplied by $\eta_{C°\pi_C}$ the overall price effect term is negative. Empirically, increases in W_w tend to decrease fertility (Borg, 1989; Schultz, 1985, 1997), which means the net effect of what must be a negative price effect and positive income effect is itself negative, but this is not pre-determined from this theory.

The case becomes more complex when "child quality," in terms of child education and health (E, H), and leisure (L_h, L_w) are restored to the model. Empirically, child quantity and quality have been shown to be substitutes (Hanushek, 1992; Schultz, 1997). Thus an increase in W_w could have ambiguous effects on C, G, E, and H depending also on dimensions such as the relative time intensity of E and H. Rather than make any assumptions about how individuals respond in this ambiguous case, this essay empirically investigates the relationship between economic opportunities for women and fertility.

Despite the shortcomings of the unitary household model, it provides a helpful starting point for conceptualizing how individuals make decisions or allocate goods within the household, particularly in terms of the impact of W_w. If either the husband or the wife were the sole decision-maker, as long as the decision-maker derived utility from both children and other goods, the model's implications would be the same. The issue becomes more complex in considering a bargaining model, since changes in women's employment opportunities might also affect their bargaining power. The implications for fertility would therefore also depend on the variation in preferences of husbands and wives for children. In Egypt, on average women report that their husbands would like more children than they themselves would prefer (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015), suggesting another potential mechanism through which declining public sector employment might lead to increases in fertility is through decreases in women's bargaining power.

3.4 Methods

The ultimate goal of this essay is to estimate the impact of employment opportunities, particularly government employment, on fertility, and to shed light on whether decreases in government hiring might have contributed to the recent rise in fertility in Egypt. There are two important econometric steps in this task. First, estimates are generated of the effect of employment on the probability of childbearing. For reasons that are discussed below, this requires estimating survival analysis (also known as hazard, duration or time-to-event) models parameterizing the relationship between employment and the annual probability of giving birth. Endogeneity of employment is a serious problem in estimation, as explained in more detail below. Second, the estimated survival analysis parameters are used to simulate how the relationship between employment and the probability of giving birth affects fertility rates.

This section describes the methods used to model these relationships. The first sub-section describes summary measures of fertility. The second sub-section discusses the need for and implementation of survival analysis methods. The third and fourth subsections describe instrumental variable and fixed effect methods to account for the endogeneity of own employment. The fifth sub-section discusses the transformation of survival analysis results into summary measures of fertility.

3.4.1 Describing Fertility

There are many ways of measuring fertility and different measures do not necessarily move together. Each measure has its advantages and drawbacks, both conceptually and in empirical implementation based on survey data. Completed fertility rates (CFRs) are, in one sense, the best measure of fertility. These rates are the number of births to women who have completed their childbearing, and represent the essential concept of fertility, the number of children a woman will have over her lifetime. However, these rates only can be calculated for women past their childbearing years, and as such, are essentially decades out of date for the purpose of studying current childbearing (Bongaarts & Feeney, 1998). Other measures must be used to assess the behavior of women currently bearing children.

There are two common measures that underlie alternative calculations of fertility rates, one based on recent childbearing across ages (age-specific fertility rates) and one based on parity (births to date) and duration-specific birth probabilities (the parity progression ratio) (Ní Bhrolcháin, 1992). Different combinations of these approaches have been used in modeling the impact of covariates on fertility measures (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010; Van Hook & Altman, 2013). Elements of both are used in the essay, as explained below, so both are described, along with additional summary measures such as the crude birth rate.

Age-specific fertility rates (ASFRs) are calculated for age groups from age *x* to *x+n* (i.e. 15-19) as in Palmore and Gardner (1994):

$$ASFR_{x,n,s} = \frac{B_{x,n,s}}{P_{x,n,s}} \tag{3.19}$$

Here the numerator, $B_{x,n,s}$, is the number of (live) births that occurred within *s* years or months preceding the survey, for women who were *x* to *x+n* years of age at the time of the birth. The denominator of the ASFR, $P_{x,n,s}$, is the number of woman-years lived in the age bracket from age x to age $x+n$ in the s years or months preceding the survey (El-Zanaty & Way, 2009; Palmore & Gardner, 1994). ASFRs therefore represent the annual probability of childbearing at a specific age. These statistics are typically presented multiplied by 1,000 since probabilities at a given age may be low.

There are a number of important details to note about estimating these rates. Women's age at the time of birth is used to categorize women rather than their current age so that statistics are not driven by the length of s.[50] Age groups are usually five-year brackets, and s is typically the three years preceding the survey, conventions this essay follows. The women-years included in the ASFR estimate are for all women in the age bracket, regardless of marital status. Since fertility questions are typically asked for women in a specific age range, such as women aged 15-49, fertility for the oldest age group surveyed, in this case the group aged 44-49, is necessarily truncated. For instance, if one looks back two years one has data only on women aged 44-47 two years ago, since the women aged 48-49 two years prior to the survey were 50-51 years old at the time of the survey and thus were not asked the fertility questions.

The advantage of ASFRs is that they are relatively up-to-date, in reflecting the behavior in recent years of a specific age group. They also are useful for information on when, in a woman's lifetime, childbearing is taking place. The disadvantage of ASFRs is that they do not convey meaningful aggregate information about population trends. They do not directly indicate the number of children a woman will bear over her lifetime, an essential fact about fertility.

However, estimated age-specific fertility rates can be used to calculate the total fertility rate (TFR). Because later an alternative method for calculating the TFR, based on parity progression ratios, is presented, denote the TFR based on the ASFRs as the TFR_{ASFR}. The TFR_{ASFR} is essentially the cumulative lifetime fertility implied by the

[50] If current age at the time of the survey were used instead of age at the time of birth, increasing s would erroneously attribute increasing numbers of births to later ages.

ASFRs. The TFR_{ASFR} is calculated as the sum of the ASFRs over each age, x, (Palmore & Gardner, 1994):

$$TFR_{ASFR} = \sum_{x} ASFR_{x,s} \tag{3.20}$$

When five-year age group ASFRs are estimated, it is assumed that the rates for each single year are the same as throughout the age bracket. The TFR_{ASFR} measure represents the number of children a woman would have during her childbearing years if she bore children at the ASFRs during those years and survived until the end of her child-bearing years (Palmore & Gardner, 1994).

A number of challenges occur in calculating these rates from survey data. One is the issue of recall; asking women about their lifetime childbearing is subject to substantial recall bias, particularly for older women or women with high fertility. By restricting the period under investigation in the ASFR (and therefore the TFR_{ASFR}) to the past few years, this issue is diminished, although not necessarily eliminated, since, for instance, infants who died may be overlooked. Accurate reporting of ages for women may also be a problem; certainly heaping at five and ten year ages is observed empirically in many datasets. The five-year age brackets may help with this age heaping, since over-represented ages will be grouped with under-represented ones.

Certain assumptions are also made in terms of who is asked questions about fertility. The DHS surveys in Egypt ask ever-married women ages 15-49 about their birth histories. Fertility among never-married women is therefore assumed to be zero (El-Zanaty & Way, 2009). Responses about marital status among young women may not be accurate; the legal age of marriage in Egypt for women is now 18, and this may discourage accurate reporting of the marital status for women 15-17. Selective mortality can be an issue if women who have more children are more likely to die early, a potential problem given the relationship between childbirth and maternal mortality.

An alternative measure of the total fertility rate that can be used to assess lifetime fertility is based on probabilities assessed across parities (number of children already born). This parity progression ratio (PPR) measure has the advantage of assessing the probability of whether there is a birth based on the number of children already born, likely the driving factor in childbearing, rather than a woman's age (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010). Denote as p_M the probability of ever marrying and p_B as the probability of progressing from marriage to first birth. Denote p_i as the ratio for progression from i to i+1 birth, the probability of birth i+1 after birth i. The TFR based on the PPR (TFR_{PPR}) can then be calculated as the sum of the probability of each birth, where the probability of each birth is based on multiplying out the PPRs:

$$TFR_{PPR} = p_M p_B + p_M p_B p_1 + p_M p_B p_1 p_2 + \cdots \quad (3.21)$$

In practice, since high parities are difficult to estimate past a certain point, an estimate of p_{x+} is used for births numbered x and higher. This approach assumes that all higher order PPRs at x and higher equal p_{x+} and then a geometric series is implied from x onwards. As was the case with ASFR measures, PPR measures of fertility can be limited to a certain period preceding the survey, or analyses can be done for different cohorts. The resulting estimates of TFR from ASFR and PPR measures can vary, given the different methods for calculation (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010).

Although ASFRs and PPRs are typically contrasted as separate approaches to estimate the total fertility rate, their elements can also be combined. Age-specificity along with parity and duration dimensions may best capture fertility measures (Ní Bhrolcháin, 1992; Van Hook & Altman, 2013). Because the comparator statistics for time trends, from the DHS, are based on ASFRs (El-Zanaty & Way, 2009), equivalent TFR_{ASFR} measures are reported for this essay's descriptive statistics. However, as discussed in detail below, the multivariate models used incorporate dimensions of age, parity, and duration since last birth but the simulated fertility measures are more akin to the TFR_{PPR}.

As well as examining ASFRs and TFRs, this essay also discusses estimates of crude birth rates (CBRs). Crude birth rates are calculated as the (annual) number of live births, B, per 1,000 population, P, (Palmore & Gardner, 1994):

$$CBR = 1{,}000 \frac{B}{P} \quad (3.22)$$

CBRs can be calculated either from survey data or based on national reporting and registration of births. CBRs have the advantage of being available in the interim between surveys, based on vital statistics systems. However, they are also sensitive to the distribution of the population, especially if there are differential population growth rates across fertile and other ages.

ASFRs, TFR_{ASFRs}, and CBRs are all measures to quantify births and fertility. However, these quantity outcomes are also the product of the timing of births. The demography literature distinguishes between quantum, the amount of births, and tempo, the timing of births (Bongaarts & Feeney, 1998). Measures based on ASFRs can suffer from tempo distortions. All else being equal, if the mean age at childbearing is rising (falling) then the TFR_{ASFR} will always under- (over-) estimate the true CFR the same cohort will ultimately attain. This is because, as the mean age of childbearing rises (falls), bearing the same number of children is spread out over a longer (shorter) time period.

3.4.2 Discrete-Time Survival Analysis Using the Logit Model

The relationship between childbearing and employment is of interest in this essay. However, modeling fertility is not straightforward, as many women have not yet completed their childbearing. These women are right-censored in terms of whether they will have another birth. The timing and occurrence of childbearing, accounting for right censoring, is best modeled using survival analysis (Van Hook & Altman, 2013). Specifically, this essay uses survival analysis models to estimate the effect of employment and employment opportunities on the probability of having a child. Discrete-time methods are used,[51] since the data analyzed are annual.

This essay specifically uses a discrete-time logit (logistic) model to estimate the probability of a birth occurring at a point in time (year). Either complementary log-log

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[51] Quite commonly continuous-time models such as the Cox proportional hazard model are used even when the data are discrete. However, because of how Cox estimates are undertaken without a direct estimate of the baseline hazard, simulation of outcomes in relation to a time-varying covariates is problematic and "extreme caution" (Therneau & Grambsch, 2000, p. 272) advised. Because discrete-time methods, as shown below, estimate the hazard directly, incorporating time varying covariates in simulations is more tractable.

models or logit models can be used in discrete-time survival analysis (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010; Van Hook & Altman, 2013). The complementary log-log model is a proportional hazards model, like the Cox proportional hazards model. The discrete-time logit model estimates a proportional odds model and odds ratios (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010). Both models have been used in applications simulating fertility data (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010; Van Hook & Altman, 2013). Empirically, results of the logit and complementary log-log model are similar, particularly when probabilities are small. A study estimating TFRs from survival models in the Philippines which compared the two models found similar results out to the second decimal place (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010). Because it is amenable to the incorporation of fixed effects (Allison, 2009), one of this essay's identification strategies, the logit model is used.

Controlling for individual characteristics such as place of residence, education, and age, logit models can be used to measure the effect of employment opportunities on the spacing and probability of sequential births (giving birth once married, having a second birth after a first, a third birth after a second, etc.). The dependent variable underlying these models is essentially the time, in years, from one birth to the next (or from marriage to the first birth). For estimation, this duration is transformed into the probability of having a birth in each year if that birth has not yet occurred.[52] Having a birth at a particular time, t, can be denoted as T_t. Then the probability of interest is the discrete-time hazard function, h_{it} (Jenkins, 1995):

$$h_{it} = \Pr\,(T_t | T_t \geq t) \tag{3.23}$$

[52] An alternative approach to estimating events in survival analysis is the split-population model, which relaxes the assumption common to survival models that every observation eventually experiences the event. Split-population models divide the population into those that will never experience an event and those that will. Then essentially two models are estimated, one for the probability of ever experiencing an event and one for the timing of an event (Box-Steffensmeier & Jones, 2004; Schmidt & Witte, 1989). Such separate modeling is required when a model erroneously assumes everyone eventually fails (has the event), primarily a problem in parametric models. Because the empirically estimated baseline probability of an event can go to zero in the models implemented in this essay, split-population models are not required.

The logit estimates the relationship between this hazard and covariates, X_{it}, as (Jenkins, 1995):

$$h_{it} = \frac{1}{\{1 + \exp[-\theta(t) - \beta X_{it}]\}} \tag{3.24}$$

or

$$\log\left(\frac{h_{it}}{1 - h_{it}}\right) = \theta(t) + \beta X_{it} \tag{3.25}$$

The term $\theta(t)$ is a series of dummies for the different years.[53] The estimated coefficients, $\beta,$ can be exponentiated to generate odds ratios, the relationship between a one-unit increase in a covariate and the odds of failure (giving birth). When the covariates are set to zero, equation (3.24) can be used to estimate the baseline hazard function from $\theta(t)$, the probability of having a birth at each point in time for the reference case (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010). To accommodate this modeling, the analyzed data is structured so that an observation is essentially a person-parity-year. This also facilitates the inclusion of time-varying covariates, such as employment opportunities changing over time or the year itself varying.

Since fertility is generally a repeated event, i.e. a single woman has multiple births over her lifetime, adjustments are made for the repeated nature of these events. The data are structured such that a woman is not at risk for birth *N* until birth *N-1* has occurred. Controls are included to account for the fact that the baseline hazard will vary over different births (Prentice, Williams, & Peterson, 1981). Models incorporate a fully interacted set of parity (number of children already born) and time ($\theta(t)$) dummy variables as controls to account for any potential heterogeneity in baseline hazards. Essentially the baseline hazard (probability) of each parity (first, second, third, etc.) at each year (0-1 year since last birth (or marriage), 1-2 years since last birth (or marriage), etc.) is estimated. Additionally, models include clustered standard errors to allow for potential correlation across years within parities, across parities for specific women, or among women in the same PSU.

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[53] Year here in the sense of years from last birth or marriage, not calendar year.

3.4.3 Instrumenting for Own Employment

Although the logit model can allow for a rich set of covariates, estimates of the causal impact of employment on fertility are likely to be biased due to the potential endogeneity of employment. One potential cause of endogeneity in this context is omitted variables. For instance, unmeasured local cultural norms that discourage women's employment and encourage their childbearing could lead to estimates of the impact of women's employment on fertility that are biased in the direction of a large negative impact. Reverse causality or simultaneity, wherein women might leave employment or enter employment because they have had a child (rather than have a child because of employment) or might make a joint decision about employment and childbearing, are also likely to be problems. These problems are also likely to bias the impact of public sector employment on fertility in the direction of a large negative impact.

In general, there are several potential methods for overcoming endogeneity. Incorporating additional observable characteristics can help address the fundamental underlying problem of omitted variables. For instance, most of the models estimated include a full set of governorate of birth dummies interacted with urban/rural residence, which are likely to absorb a substantial share of the effect of local cultural norms. This essay includes a rich set of covariates, described in the data section below, to try to control for such differences. Identification of the impact of employment is unlikely to be achieved through controls alone, however, as unobserved individual tastes for work and children cannot be controlled for. Two methods might potentially alleviate these challenges and allow for causal identification: one is instrumental variables and the other is woman-level fixed effects.

A potentially viable instrument for women's own employment is urban/rural-governorate level employment opportunities (in a woman's place of birth, which is less likely to suffer from location endogeneity[54]). There is not, however, a well established practice for estimating a discrete-time duration model with instrumental variables. A number of challenges arise in instrumenting for employment, a binary variable, in the

[54] Most ever-married women (84%) currently reside in their governorate and urban/rural location of birth.

context of a nonlinear duration model. Predicting the endogenous variable in a nonlinear regression framework (i.e. using a logit, probit, etc.) in the first stage of instrumental variables estimation will only be consistent if the assumed functional form is exactly right (Angrist & Krueger, 2001). Problems may also arise in a non-linear second stage.

The problems with the non-linear case suggest that linear approaches should be used, namely two-stage least squares (2SLS), since there are no restrictions in the assumptions of 2SLS as to whether the endogenous variables or instruments are continuous or discrete (Angrist & Krueger, 2001; Wooldridge, 2002). However, the underlying model for 2SLS is additive, and it is quite obvious that duration models are not likely to be additive. Consider the case at hand, where the impact of public sector employment is of interest. The impact of employment is not simply going to be a 2 percentage point lower annual probability of birth, which is the sort of estimate that one would obtain from a 2SLS model that is essentially a pair of linear probability models for employment and childbearing. This 2 percentage point estimate averages over the effects of many years, ages, and parities, including at times when the baseline hazard is quite high, perhaps a 30% chance, to times when the baseline hazard is very near zero. A multiplicative functional form, such as a 95% chance of childbearing, is much more appropriate.

The preferred approach in inherently non-linear settings is an instrumental variables control function approach (Wooldridge, 2015), also called two-stage residual inclusion (2SRI) in the health literature (Terza, Basu, & Rathouz, 2008). This approach has been demonstrated to perform better than alternatives in simulations for a variety of non-linear outcomes (Terza, Basu, & Rathouz, 2008; Terza, Bradford, & Dismuke, 2008) and also shown to perform well in a survival analysis setting (Carlin & Solid, 2014). Additionally, alternative methods such as joint quasi-maximum likelihood estimation are problematic in a case with discrete outcomes or discrete endogenous variables, such as both childbearing and employment. Control function/2SRI methods provide a simpler approach in such contexts (Wooldridge, 2014).

Consider the case where the outcome of interest, *y*, is based on a nonlinear function, *M*( ), and the regressors, *x*, can be partitioned into those that are endogenous, *e*, observable (and observed) confounders, *o*, and unobservable confounders u (Terza, Basu, & Rathouz, 2008):

$$y = M(x_e\beta_e + x_o\beta_o + x_u\beta_u) + \varepsilon \tag{3.26}$$

The unobservable confounders are correlated with the endogenous variables, specifically there is some auxiliary equation for the endogenous variables:

$$x_e = r(w\rho) + x_u \tag{3.27}$$

where *w* includes both x_o and instrument(s) *z*. Here the instruments, *z*, must satisfy the usual assumptions (Terza, Basu, & Rathouz, 2008):

- x_u are not correlated with *z*
- *z* are sufficiently correlated with x_e (no weak instruments)
- *z* have no direct influence on *y* and are not correlated with ε (exclusion restriction)

With this notation and these conditions, the control function/2SRI approach estimates a first stage of:

$$\widehat{x_e} = r(w\hat{\rho}) \tag{3.28}$$

Which yields residuals:

$$\widehat{x_u} = x_e - r(w\hat{\rho}) \tag{3.29}$$

The second stage estimator allows for a non-linear model:

$$y = M(x_e\beta_e + x_o\beta_o + \widehat{x_u}\beta_u) + \varepsilon^{2SRI} \tag{3.30}$$

Here ε^{2SRI} is the error term from the second stage.

In the linear case, this is identical to 2SLS. In the non-linear case, the parameters of 2SRI characterize the conditional mean and are consistent, but 2SLS estimates are inconsistent (Terza, Basu, & Rathouz, 2008). Initially proposed as a specification test for endogeneity (Hausman, 1978), variations on residual inclusion approaches have been specified for count outcomes (Mullahy, 1997; Wooldridge, 1999, 2002) and binary outcomes (Rivers & Vuong, 1988). In the case at hand, 2SRI is used in the previously discussed survival analysis framework of logit estimation, with an instrument (a *z*) of governorate-urban/rural public sector employment for own employment in a particular year based on a linear probability model. Standard errors are bootstrapped, with clustering at the PSU level.

Public sector employment on an annual governorate-urban/rural basis merits some discussion as to its exogeneity and validity as an instrument. It is quite possible that public sector employment is correlated with some unobserved factors that do matter—such as the local availability of health services and general economic development—but these conditions are controlled for. In general, local government employment is centrally set (Assaad, 1997a) and cannot be modified by individuals, so the instrument cannot be manipulated. Additionally, as discussed in detail in the data section below, there are 38 unique combinations of urban/rural and governorate and 21 years of annual local measures used, which provide variation in the instrument, an important element of identification. Overall, using local government employment to instrument for own employment should address both omitted variables and potential reverse causality or simultaneity of employment.

3.4.4 Incorporating Fixed Effects Using the Conditional Logit Model

Identification of the effect of own employment on fertility can also potentially be achieved using a survival analysis woman fixed effect model to difference out unobserved characteristics on the woman level. The survival analysis literature tends to address the issue of unobservable heterogeneity across individuals with what are referred to as "frailty" models, where frailty is an unobserved random effect for an individual or group. Frailities are included in the hazard function, and can be modeled with a variety of different distributions, including normal and gamma distributions (Moeschberger & Klein, 2003). However, as with random effect models in general, using frailty to account for unobserved heterogeneity in hazard models requires assumptions that the random effect is independent (Murphy, 1995) and therefore uncorrelated with the X_{it}. Also, in general, the distribution of the error has to be assumed to follow a specific functional form.

A better method for accounting for unobserved heterogeneity is a fixed effect model, specifically (Allison, 2009):

$$\log\left(\frac{h_{it}}{1-h_{it}}\right) = \alpha_i + \theta(t) + \beta X_{it} \tag{3.31}$$

with α_i being a fixed effect for a particular woman. Estimation using dummy variables for each woman tends to suffer from typical panel data incidental parameters problems (Chamberlain, 1980) and performs poorly in survival analysis applications (Duchateau & Janssen, 2007). The one model that performs well for discrete outcomes while incorporating fixed effects is the conditional logit model, which uses conditional maximum likelihood estimation such that the α_i themselves are not estimated (Allison, 2009; Wooldridge, 2002). Therefore, fixed effect logits (conditional logits) for individual women are estimated over different years and births. Fixed effects for multiple durations (births) on a single unit (an individual woman) remove biases related to time-invariant woman-specific effects and are especially important when the woman-specific effects are correlated with covariates. Essentially, this method creates woman-specific fixed effects across the timing and probability of different births.[55] Women act as their own controls. This method should be effective for removing unobserved characteristics that are constant for women over time, such as fixed preferences for children, other goods, and leisure/work.

Using own employment in a fixed effects model will likely not overcome problems of reverse causality. For instance, women may still exit jobs when they are planning to have a child, creating spurious results. However, variation in local employment opportunities can be considered exogenous after absorbing any time-invariant characteristics of women (and their birth locales) into a fixed effect. Government employment opportunities will be correlated with own employment but

[55] This approach is slightly different than that for continuous time in the Cox proportional hazard model, wherein individual strata can be used to simulate fixed effects. The individual strata allow each woman to have her own baseline hazard because the baseline hazards drop out in partial likelihood estimation (Allison, 2009). In the conditional logit, women have their own effects on the hazard, but not their own baseline hazards. For the case at hand, this is akin to assuming certain women have fewer, more spaced out births while others have more, more closely spaced births.

should not suffer from the remaining endogeneity problem, reverse causality or simultaneity, of own employment. Essentially, a reduced form of the instrumental variable model can be estimated using government employment opportunities directly along with woman fixed effects, in addition to the 2SRI models that instrument for employment directly.

3.4.5 From Multivariate Methods to Fertility Estimates

While survival models produce hazard estimates that indicate important relationships, of particular interest are changes in summary measures, such as total fertility rates. It is possible to translate hazard model coefficients into total fertility rates, since essentially probabilities are being modeled. Both Van Hook and Altman (2013) and Retherford et al. (2010) illustrate similar methods for estimating total fertility rates from discrete-time survival models. Once the discrete-time hazard model has been fitted, predicted hazards, a_{jk}, are simulated for the probability of having a birth at each duration from the previous birth (or marriage), k, and parity, j. In order to translate the hazards into fertility measures like the TFR, the conditional probability represented by the hazard must be translated into the unconditional probability of a birth. For each parity and duration since last birth, the a_{jk} are multiplied by the proportion b_{jk} at risk of birth j at duration k, to produce an unconditional probability, c_{jk}:

$$c_{jk} = a_{jk} b_{jk} \tag{3.32}$$

Since the models are specifically for the duration from marriage to the first birth, etc., the proportion at risk initially for a first birth is the proportion who ever marry.[56] The proportion at risk for b_{j0} after the first birth is the sum over k of c_{j-1k}, for example the group at risk of a third birth is the share of women who ultimately have a second birth. The b_{jk} at risk evolve within a parity based on the probability of progressing from one parity to the next at each duration:

$$b_{jk} = b_{jk-1} - c_{jk-1} \tag{3.33}$$

[56] Implemented here based on the rates in the 2014 DHS (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015).

The parity-specific TFR can then be calculated as the sum of c_{jk} over all durations (Van Hook & Altman, 2013):

$$TFR_j = \sum_k c_{jk} \tag{3.34}$$

After this calculation has been sequenced across each of the parities, then the overall TFR can be calculated as (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010; Van Hook & Altman, 2013):

$$TFR_{PPR} = \sum_j \sum_k c_{jk} \tag{3.35}$$

This is the sum of the probabilities of births across all possible births and durations over the reproductive lifetime (assuming no mortality). As with other measures of fertility, these simulations provide the TFR for what would occur if women experienced all of the predicted probabilities from the hazard model over their reproductive lifetimes (Van Hook & Altman, 2013). The simulated TFRs can incorporate covariates, x, into the predicted hazards, a_{jk}, as a_{jkx}. The covariates, x, can be varied to simulate TFRs for different profiles, for instance for a public-employment profile as compared to a no-public-employment profile. Standard errors can be generated around the TFR estimates for different profiles using bootstrapping (Van Hook & Altman, 2013).

3.5 Data

This essay uses the Egypt Labor Market Panel Survey (ELMPS), a rich panel data set that includes detailed information on individuals' labor market and demographic characteristics. The ELMPS is a household survey with three rounds to date: 1998, 2006, and 2012. The 2006 and 2012 rounds include both previous round households, split households, and a refresher sample. In 2012, the sample totaled 12,060 households and 49,186 individuals. Each round includes a detailed work history for all individuals 15-64 who ever worked, and the 2006 and 2012 rounds include detailed fertility data for ever-married women. The rounds are nationally representative at the time of fielding, and the data include weights that account for sample attrition processes.[57]

3.5.1 Outcomes

Fertility histories from 2006 and 2012 are used to identify the timing and number of births for descriptive measures of fertility. Birth history data are available for women aged 18-49 in 2012 and 16-49 in 2006, and they include the year and month of each live birth starting from the first child. For the multivariate models, only the 2012 round is used to have the greatest time span of years incorporated.[58] The birth history data and the date of first marriage are used to construct the length of birth intervals in years,[59] that is the time from marriage to the first birth, the first birth to the second, the second to the third, the third to the fourth, etc., the underlying outcomes used in the analysis. These outcomes can be right censored if a birth has not yet occurred, or will never occur. As is common with duration outcomes, information on both the time until an event (birth) and whether it occurs are captured jointly by the length of the interval and whether it ends with another birth or is right censored.

3.5.2 Covariates

Labor market histories from all three rounds (1998, 2006, and 2012) are used to construct annual data on individuals' labor market statuses. The data include information on the start year of each status,[60] the type of employment (wage work, employer, self-employed, unpaid family work), and the sector of employment (public/private). An annual individual work history measuring participation in the public sector is constructed

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[57] See Assaad and Krafft (Assaad & Krafft, 2013) for additional information on the ELMPS. Weights are used with this essay's descriptive statistics. Regressions do not use sampling weights since sampling is unrelated to the dependent variable and in such a case unweighted methods are preferred (Deaton, 1997; Winship & Radbill, 1994).

[58] Comparisons of annual fertility rates for the early 2000s indicate relatively comparable data for that period across the ELMPS 2006 and ELMPS 2012.

[59] Although data are collected for the month of birth, there is a substantial share (9%) of "don't know" responses for the month of a birth, making annual analyses preferable.

[60] Although data are collected for the month of status start, the large share of "don't know" responses makes annual analyses preferable as well as consistent with the use of annual birth history data.

over time based on the 2012 data. Analyses comparing the contemporaneous (panel) data to the retrospective data across rounds suggest that the quality of retrospective reports of public sector employment is relatively high. Consistency of reporting across panel and retrospective data for public sector jobs was in the range of 85-89%, with slightly more consistent reporting among women than men (Assaad, Krafft, & Yassine, 2015). This suggests that while there may be some measurement error attenuating the coefficient on public sector employment, attenuation is likely to be small.

Since local employment opportunities are themselves of interest and, as an instrument, may address endogeneity problems, individuals' participation in public sector work is also aggregated into annual means at the urban/rural and governorate level based on place of birth[61] for individuals 25-39.[62] There are 21 governorates and 38 unique combinations of governorate and urban/rural (four governorates do not have any rural areas). Histories for the six (2012) to eight years (2006, 1998) from the date of each survey backwards in time are used, to minimize recall bias while providing a substantial time span of data.

All models include year dummies as well as a fully interacted set of parity and duration since last birth or marriage dummies, which account for duration and parity dependence. A number of other covariates are included in the analyses. See Table 3.1 for summary statistics on the covariates, as measured for each woman at each parity and year (duration) since last birth, which is the data structure used in the multivariate models. Since age has an important relationship with fertility, age groups are incorporated into the analyses. The categorical educational attainment of women is incorporated, given strong relationships in the literature between education and fertility. Place of birth is controlled for, as a fully interacted set of birth governorate and urban/rural dummies, since local cultural differences and other local factors may affect fertility. As potential measures of socio-economic status, the woman's parents' education (categorically for both her mother

[61] Women not born in Egypt or born in the Frontier governorates are excluded from the analyses since these areas are not covered by the ELMPS. Because the Luxor governorate was split from the Qena governorate during the period of study the two are combined as Qena throughout.
[62] This age range is to proxy prime childbearing years among those old enough to have finished all of their schooling.

and father) is included in the analyses. Because son preference has been linked historically to childbearing in Egypt, with families with no living sons more likely to have children (Yount, Langsten, & Hill, 2000), an additional control is included for whether the woman has, as yet, borne any sons.[63] Because the data are women-years starting at marriage and many women in the sample are early in their childbearing, less than the majority of women-years (44%) have a son.

An additional set of controls attempts to measure access to health care, especially family planning, a key factor that will affect fertility. Unfortunately, access to family planning is not readily measured directly—the common measure of family planning prevalence conflates both supply and demand for family planning. As a proxy for access to family planning, prenatal care coverage is used. Data were compiled from Egyptian Demographic and Health Surveys (DHSs) for 1992, 2000, 2003, 2005, 2008, and 2014 on prenatal care coverage on a governorate and urban/rural level for births in the five years preceding each survey. Linear interpolation was used to generate trends in years between DHS surveys.

Another set of controls on the governorate level measures mean life expectancy, adult (15+) literacy, and the GDP per capita (which was translated into real 2012 Egyptian pound (LE) terms using the CPI (World Bank, 2013b)). These data were collected from the Egyptian Human Development Reports (HDRs) for 1995, 1998/1999, 2003, 2004, 2005, 2008, and 2010 (Institute of National Planning, 1995, 2000; UNDP & Institute of National Planning Egypt, 2004; UNDP & Institute of National Planning, 2003, 2005, 2008, 2010). Data were typically for one to two years prior to the report, but the date varied across indicators. These characteristics should control for general health and socio-economic conditions that might affect childbearing decisions. As with the prenatal care data, linear interpolation was used to generate local trends in years without data. Throughout the essay, although descriptive statistics are presented for the mean observed values of the incorporated continuous variables, all the continuous variables

[63] Empirical testing determined that the binary of having a son was what mattered. Beyond having a son, whether a daughter had been born or the percentage of children that were male did not affect fertility.

(prenatal care, life expectancy, adult literacy, and GDP per capita) are shifted to have a mean of zero in the multivariate analyses (the observed mean is subtracted from the observed values). This allows the baseline hazard across parities and births to be a more meaningful reference value.

A series of additional analyses are conducted controlling for spouse characteristics. Spouse data are not available for all women, as the husband may not be present due to death, migration, separation, or divorce. Approximately 89% of women included in the sample have a spouse present in the household at the time of the survey. The age group of the spouse at each year, his education (categorically, as with women), and his time-varying employment in the public sector (based on his retrospective labor market history data) are incorporated as controls in this subset of regressions. The regressions with these additional controls can help test the possibility that there are substantial fertility preference differentials among individuals and households who work in the public sector.

3.5.3 Time Period Analyzed

Given the restricted universe of fertility histories (ages 18-49) and local labor market histories (back to 1991), the analysis is limited to the period 1991 to 2011. The oldest women with fertility histories, age 49, would have been 28 in 1991, which is above the 75th percentile for age at first birth (as shown in Figure 3.5 below). The time frame therefore provides the largest time window possible with reliable coverage of fertility and labor market histories. Women enter this data once they have married, so long as they married between 1991 and 2011.[64] Restricting the analysis to women who married in 1991 or thereafter essentially restricts the data to entry cohorts into motherhood, which are ideal for survival analysis.

[64] In order to be able to simulate fertility, women do not leave this model if they become separated, widowed, or divorced. These events are, however, fairly rare during fertile years. For instance, just 2.9% of women 40-44 were divorced and 5.9% widowed (Salem, 2015).

3.6 Descriptive Patterns of Fertility and Employment

3.6.1 Trends in Total Fertility Rates

An important initial result of the analysis is that fertility has risen recently in Egypt. Figure 3.1 presents fertility trends in Egypt, specifically the TFR (based on the ASFR) as measured by various surveys, primarily Demographic and Health Surveys over the period 1980-2014 (El-Zanaty & Way, 2009). Additionally, Figure 3.1 includes the TFR calculated from the 2012 ELMPS. In 1980, the TFR was quite high, at 5.3, and declined rapidly, falling to 3.6 by 1995. Since 1995, there have been moderate fluctuations in the TFR, but over the period 2000-2008 it declined from 3.5 to 3.0. The 2006 round of the ELMPS found a TFR of 3.0, consistent with the 2005 DHS (TFR of 3.1) and 2008 DHS (TFR of 3.0). However, the 2012 ELMPS indicates a substantial rise in fertility, to a TFR of 3.5. The trend of rising fertility has since been confirmed in the 2014 DHS, which found a TFR of 3.5 as well (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). This essay argues that one of the factors contributing to these patterns, especially the flattening and then rise in fertility, is diminishing economic opportunities for women in Egypt.

3.6.2 Trends in Age-Specific Fertility Rates

The ASFRs underlying the TFRs also present a number of important trends (Figure 3.2). The general decline in fertility over 1980-2000 was driven by particularly steep declines in ages 25-44, with smaller decreases at the youngest ages, consistent with women rapidly having a first child after marriage (which typically occurs in the 20-24 age bracket, as discussed below). The results for the ELMPS rounds of 2006 and 2012 are generally consistent with the DHS surveys. The recent uptick in fertility from 2008-2012 included substantial increases for age groups 20-39. The 2014 DHS results suggest that fertility is continuing to shift to younger ages, even to the extent that it is decreasing at older ages.

3.6.3 Trends in Crude Birth Rates

There are a relatively finite number of data points for ASFRs and TFRs, since they depend on surveys; however, Egypt has a vital statistics systems that generates annual estimates of crude birth rates (CBRs), providing more frequently collected data. CBRs are births per thousand of population, and will be affected by the age structure of the population, as well as underlying fertility patterns. Figure 3.3 presents the CBRs for Egypt over the period 1988-2013. Starting in 1988, the CBR was 37.8 births per thousand population. It declined rapidly through the early 1990s, fluctuating in the 28-26 range from 1992 into the 2000s. Starting in 2007, the CBR began to rise substantially, reaching 31.9 in 2012, and 31.0 in 2013. The CBRs in Egypt track quite closely with the TFRs (Figure 3.1), which hit a low of 3.0 in 2008 based on data for the preceding 1-36 months, i.e. the low period of 2005-2007 in the CBRs, and have risen to 3.5 in 2012 and 2014, consistent with higher CBRs over 2009-2013.

3.6.4 Trends in Age at Marriage and Family Planning

Two key issues that must be examined in reference to fertility changes are patterns in the age of marriage and use of family planning. In Egypt almost all births occur within marriages, so the timing of marriage essentially determines when women are at risk of becoming pregnant. Figure 3.4 displays the trends in the proportion of women married by various ages in Egypt by year of birth. For instance, among women born in the 1960s, less than 10% were married by age 15, a little more than 25% were married by age 18, more than 50% were married by age 21, and nearly 75% were married by age 24. The proportion of women married by ages 15 through 21 steadily declined for women born in the 1960s through about 1980. Starting around the 1980 birth cohort, while the proportion of women married by age 15 continued to decline, the proportion of women married by various older ages, particularly age 21, increased. Essentially, in Egypt, while marriage at younger ages was decreasing for the cohorts born in 1960 through the late 1970s, for cohorts born in the 1980s through 1990s, more women were marrying at younger ages, particularly in their early 20s. Marriage also remains nearly universal in Egypt; by their late 30s almost all women marry.

Additionally, first births follow closely the timing of marriage. The prompt arrival of a child subsequent to marriage is the norm; the 2014 DHS for Egypt found that just 2% of ever-married women age 15-49 consider it appropriate to use family planning before the first pregnancy, while 92% thought it was appropriate to use family planning after the first birth (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). The timing of the first child is much less likely to be affected by access to family planning methods or socio-economic change. Only the age at marriage is likely to drive the timing of first births. Figure 3.5 demonstrates this empirically, tracing the distributions of age at first marriage and first birth over time in Egypt for the 25th, 50th, and 75th percentiles of each distribution. As well a clear pattern of co-locomotion, the persistence of an approximately two year gap between marriage and first birth over time and over the distribution is evident. For example, 50% of women born in 1970 had married by age 21, and 50% had their first birth by age 23. The trends in age at marriage—rising and then falling—will inevitably shape measures of fertility.

Another key factor that intersects with fertility is the use of family planning methods. Use of family planning is an outcome of both supply and demand dimensions, including a couple's desired fertility, their knowledge of planning methods, and their access (including financial access) to such methods. The ELMPS does not ask about family planning behaviors. However, Egypt DHSs have detailed information on this topic. Figure 3.6 presents the percentage of currently married women (ages 15-49) using family planning methods (modern or traditional)[65] over time in Egypt based on the DHS surveys. Starting in 1980 just 24% of married women were using family planning. This rate rose fairly rapidly to 48% of women by 1991. The rate of increase slowed in the 1990s, with 56% of women using family planning by 2000 and 60% by 2003. Since

[65] Methods of family planning incorporated into this statistic include modern methods (female sterilization, the pill, IUDs, injectables, implants, male condoms, diaphragm/foam/jelly, other), and traditional methods (periodic abstinence, withdrawal, prolonged breastfeeding, other) (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015).

2003, the rate of family planning use has changed very little, with 59% of married women using family planning in the 2005 DHS, 60% as of the 2008 DHS, and 59% as of the 2014 DHS (El-Zanaty & Way, 2009; Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). This plateauing may be in part due to policy changes. USAID was a substantial supplier of contraceptives in Egypt for many years. In 2004, USAID began shifting responsibility for contraceptive supply onto the Egyptian government, with the government taking full responsibility by 2007 (USAID, 2011).

Although there remains some unmet need[66] for family planning in Egypt (12% as of the 2008 DHS and 13% as of the 2014 DHS), there has also been a rise in the "total wanted fertility rate," that is the fertility rate if unwanted births were excluded from the numerator of the TFR. The total wanted fertility rate has risen from 2.4 as of the 2008 DHS to 2.8 as of the 2014 DHS (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015), suggesting that couples are actively deciding to have more children. The reasons for this preference for additional children are likely to be complex, but one potential factor is women's lack of employment opportunities.

3.6.5 Trends in Employment

The question this essay investigates is whether recent increases in fertility in Egypt might be caused, in part, by decreases in employment opportunities for women due to the shrinking role of the public sector in employment. Figure 3.7 demonstrates the declining availability of public sector employment by showing the share of the population 25-39 in each year[67] working in the public sector over time based on the labor market histories in the ELMPS 2012. There has been a steady decline in public sector work over the 1991-2012 period, from 24% of 25-39 year-olds employed in the public sector in 1991 to 14% in 2012. Males experienced a more rapid decline, from 33% to 18% over the

[66] The unmet need statistics presented here are the percentage of fecund women who are (i) not using contraception (neither modern nor traditional methods) and who (ii) wish to postpone the next birth or stop childbearing entirely (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015).

[67] This group is of an age to have finished even a higher education and potentially be working. It is also, for women, peak childbearing ages.

period, while the share for females fell from a high of 15-16% in the 1990s to 10% by 2012. Although this decrement is unlikely to be the sole factor driving increases in the fertility, the decline in government employment opportunities could be having important implications for fertility decisions.

3.6.6 Employment and Family Formation

Public sector work and non-wage work are much more easily reconciled with marriage and family formation. Figure 3.8 shows how women's market work evolves in the years leading up to and after their marriages. An increasing share of women engage in market work (largely due to finishing school and entering the workforce) in the years leading up to marriage. However, at marriage almost half of those working in the private sector leave private sector wage work, but the shares in public sector work and non-wage work (being an employer, self-employed, or an unpaid family worker) continue to increase. Thus, in addition to public sector opportunities prior to marriage, which may affect the timing of marriage, as well as work and childbearing after marriage, the trends in public sector opportunities will affect fertility after marriage by providing women with more or fewer opportunities for work.

3.6.7 Patterns of Fertility by Characteristics

Fertility is linked with a number of women's individual and household characteristics. Table 3.2 shows the relationship between TFRs and different characteristics of women and their households and how these relationships have varied from 2006 to 2012. Differences must be interpreted with some caution since, in addition to sampling variability, different tempo effects could be occurring for different groups. The first characteristic examined is whether women ever worked in a public sector job. In 2006, the TFR for women who had worked in the public sector was 2.6, compared to 3.0 for those who had not. In 2012, the rate had risen for both groups but the gap remained; those women who had ever worked in the public sector had a TFR of 3.2, compared to 3.5 for those who had not. The rise in TFR for both groups suggests that although the decline in public sector work may be one factor contributing to rising TFRs, it is definitely not the only factor. Additionally, a number of other characteristics, such as education, may be behind the observed link between fertility and public sector work.

Fertility is closely linked to education, but the relationship is not monotonic. The TFR is highest for illiterate individuals in 2012, 4.0, while literate but uneducated individuals have a TFR of 3.0. Primary educated individuals have a TFR of 3.7, preparatory educated individuals a TFR of 3.5, vocational secondary graduates a TFR of 3.9, post-secondary institute graduates a TFR of 2.9, and university and above graduates a TFR of 3.2 as of 2012.[68] Looking at the evolution of the relationship between fertility and education over time, it is notable that vocational secondary graduates—the group that previously had guaranteed employment in government and has experienced the largest decrement in government employment opportunities across generations (Amer, 2015; Assaad & Krafft, 2014)—also had the greatest increase in TFR from 2006 to 2012, from 3.1 to 3.9. Still, TFRs have increased for all education levels, even to a similar extent for the illiterate and those with university education.

Looking at geographic differences, urban areas have a lower TFR (3.2) than rural areas (3.7) in 2012, and both experienced increases in fertility over 2006 to 2012, as did all regions, but to varying extents. In 2012, the Alexandria and Suez Canal region had the lowest TFR, 2.8, followed by Greater Cairo and urban Lower Egypt, then urban Upper Egypt and rural Lower Egypt, with rural Upper Egypt having the highest TFR in 2012, at 4.0. Women living in poorer households have higher fertility; those in the poorest 20% of households have a TFR of 3.9, those in the middle three quintiles 3.5-3.6, and those in the richest quintile 2.9. Fertility decreases with both mother's and father's education, but not monotonically. Overall, individual and household characteristics are related to fertility, but increases in fertility have been occurring, albeit to varying extents, across the board.

[68] Bootstrapped standard errors, estimated with clustering, indicate that, first, the differences in total TFR from 2006 to 2012 are statistically significant. Second, many of the differences by characteristics within a year, such as by education in 2012, are statistically significant. Third, many of the changes that have occurred over time within groups appear to be statistically significant as well.

3.7 The Relationship between Fertility and Employment

This section presents the results on the impact of employment on childbearing across the different estimation methods. The section begins with the baseline hazards of childbearing by years since previous birth and parity. Then the discrete-time survival analysis (logit) models are estimated to see the impact of public sector work on fertility, incorporating a number of controls. Models are also estimated with women fixed-effects as well as incorporating local employment opportunities instead of own employment to address the likely endogeneity of working in the public sector. Additionally, instrumental variable models using local employment opportunities as an instrument for women's employment are estimated. Lastly, the impacts on fertility of different patterns of employment opportunities are simulated, to assess the impact of changing opportunities for public sector employment on the TFR.

3.7.1 Baseline Hazards of Fertility

The first discrete-time hazard (logit) model estimated includes only a fully interacted set of parities and years since last birth or marriage. Predicting from the coefficients of this model onto a simulated full set of parities and years allows for an examination of the probability of having a child in a given year, depending on the parity and time since last birth or marriage, and conditional on not yet having shifted to the next parity.[69] Figure 3.9 presents the hazards for the model with just parities and time since last birth or first marriage. Hazards are highest immediately following marriage. Notably the hazard of having a second or higher order birth in the year immediately following the previous birth is low, which suggests women are actively spacing births. Hazards rise in the second year after the first birth and peak in the third year, with a 0.48 probability of having a second child at that point (if that point is reached). Hazards remain high but decline gradually thereafter. Hazards of a third birth show a less steep increase over time, increasing from year 1 to 2 and 3 but peaking at a hazard of 0.24 before declining slowly.

[69] Throughout, fifth and higher order parities are coded as a single category for parameter estimation, as are intervals of 10 years and longer.

Hazards for the 4th, 5th, and 6th birth onward follow relatively similar trajectories, with hazards peaking a little later, four years after the last birth, and never rising above a 0.15 probability. These interactions between parity and time since last birth or marriage are incorporated into all of the models but not presented in detail hereafter. Using the methods for estimating fertility based on hazard models discussed above, this sample of women entering matrimony from 1991-2011 has a TFR of 3.5, consistent with fertility patterns over this period (Figure 3.1).

3.7.2 Discrete-Time (Logit) Models of Fertility

The first discrete-time hazard (logit) model estimated for the relationship between fertility and a woman working in the public sector is presented in Table 3.3, specification 1. In addition to women's public sector employment status in each year, this model includes only the baseline hazards by interacted parity and time since last birth (not shown). The results presented for the model are odds ratios. When greater than 1, they mean a greater odds (probability) of birth, and when less than one they mean a lower odds (probability) of birth. Their statistical significance can be evaluated with the standard errors in terms of deviations from 1. In specification 1, the odds ratio of 0.810 for public sector work means that the estimated odds of a woman who is working in the public sector giving birth are 81.0% of the estimated odds for a woman who is not working in the public sector. This is a large effect size, but no other covariates are included and fertility is clearly associated with a host of (omitted) characteristics here.

In specification 2 (Table 3.3), controls are added for the woman's age group, her education, her parents' education, her place of birth, local characteristics, and the year. Once these are included, the odds ratio for a woman being engaged in public sector work rises to 0.976 and becomes statistically insignificant. The implications for completed fertility (TFRs) of this estimate and other models are discussed in a following section on fertility simulations.

Notably, a number of other characteristics are statistically significant in specification 2. There are significant differences by age compared to the reference age group of 30-34; younger women have significantly higher odds while older women have lower odds, which drop substantially with age. Compared to those who are illiterate, there are some significant differences by education. Those with a primary education have significantly lower odds (0.867), while those with university and above education have significantly higher odds (1.157), which runs counter to the narrative of increases in women's education decreasing fertility. The unexpected relationship between education and fertility may be in part because of the close connection between education and social class; it is in fact mother's education, a marker of social class, that has the strongest relationships with the odds of a birth. Having a university-educated mother has a significant odds ratio of 0.777 compared to having an illiterate mother. Compared to an illiterate father, there is a statistically significant effect of having an above intermediate educated father (0.800) or a university-educated father (0.842).

Although not shown, the birth governorate-residence interactions are often, but not always, statistically significant. Compared to urban Cairo, governorates in urban Greater Cairo and urban Lower Egypt tend to be only insignificantly different. Urban Upper Egypt and rural areas are significantly different, with higher probabilities of giving birth than in Cairo. Turning now to the time-varying local characteristics of individuals' birth places, there are no significant differences by local adult literacy, GDP per capita (in thousands of 2012 LE), or prenatal care. Although not shown, there are some significant differences by year, which appear to reflect fluctuations more than a clear trend.

In specification 2 a woman being engaged in public sector work had an odds ratio slightly less than 1, but was not statistically significant. It is, however, likely that public sector work has potentially differential effects across births. Almost everyone has a birth right after marriage and then fairly promptly a second birth. For instance, in the specification for the baseline hazards, the estimates indicate that 95% of those with first births have second births (Figure 3.9). The majority of women who have second births go on for a third birth (80%) and most of those (63%) continue on for a fourth birth, but there is clearly more scope for an impact on later parities. Thus, it seems likely that there might be differential impacts of public sector work on different parities, with greater scope for an impact on later parities. This possibility is tested in specification 3, where a woman being engaged in public sector work is interacted with parity (compared to not working in the public sector) and, as before, controlling for parity and time since last birth or marriage, as well as the same set of other controls.

In specification 3, there are higher but statistically insignificant odds ratios for progressing from marriage to a first birth and from a first birth to a second birth when women work in the public sector, lower but statistically insignificant odds of a third birth (when women have had a second birth) and a lower and statistically significant odds ratio (0.686) of progressing from a third to a fourth birth. The odds of going from a fourth to a fifth birth are slightly greater than 1, but statistically insignificant. For the few women who work in the public sector and progress to their fifth birth, the odds of a sixth birth and above are significantly higher (2.222).[70] Thus, the evidence suggests that on what is a particularly relevant margin currently in Egypt, whether to move from three children to four, public sector work can reduce certain dimensions of fertility; however the net effects of these complex patterns on the total fertility rate must be examined through the simulations below. Additionally, although a rich set of controls is included, the relationship identified between fertility and employment is not necessarily causal; problems of endogeneity are a substantial concern.[71]

One potential concern is whether households with individuals who work in the public sector are systematically different in unobservable ways. To a certain extent, this possibility can be checked by adding parity-interacted controls for the spouse's work in the public sector to specification 3. This can be done only for the subset of women with their spouses in the household. Other controls are also added for spouse characteristics

[70] Results estimated separately by parity (not shown), which allow the impact of all covariates to vary by parity, although noisier, have a similar pattern of public sector odds ratios across parities.
[71] Shifting religious values over time or across generations are one potential source of endogeneity. Comparing changes across the Muslim and Christian populations in Egypt could shed light on how shifting religious values in the majority-Muslim country might be contributing to fertility. Unfortunately, religious affiliation is available for only a subset of women (married and 18-39 in 2012), precluding the calculation of a TFR. Models of childbearing estimated for the subset of women with religion data and adding interactions between years and religion are noisy but suggest that fertility has been rising for Muslim women to a greater extent than Christian women.

(age and education) to check whether these may also be driving forces in childbearing decisions. The results are presented in Table 3.4. Importantly, the impact of women's public sector work persists with similar odds ratios across births. The impact on moving from the third birth to the fourth birth remains statistically significant. The spouse being employed in the public sector is not statistically significant.[72]

3.7.3 Discrete-Time Models of Fertility Incorporating Fixed Effects

One way to address endogeneity is to incorporate women-specific fixed effects into estimation using a conditional logit model. As with other types of fixed effects models, the coefficients on fixed characteristics (birth place, education, and parents' education) cannot be estimated but are absorbed into the fixed effect that is conditioned out of the model. These fixed effects will also absorb unobserved time-invariant differences between women (and their households), which are likely to include important dimensions of preferences. Models can be estimated only for women who vary in their outcomes, i.e. have had at least one birth. Since 93% of women who marry ultimately have a first birth, this is unlikely to create substantial bias but may slightly inflate fertility simulations (calculated later). Additionally, the effects of various covariates, such as women's own public sector employment, can be identified only from those women with variation in these characteristics, since fixed effects estimates are based on within-woman variation. Among the women who are observed working in the public sector at some point in the time period analyzed, 37% varied over time in their public sector status.

In Table 3.5, specification 4 estimates a similar model to specification 3 with women's public sector work interacted with parities. After adding the fixed effects, a similar pattern to specification 3 is found for the interactions with lower parities. There are higher odds ratios for moving from marriage to the first birth and after the first birth (for the second birth). Lower odds ratios for giving birth after the second, especially third, and fourth birth are found. Only the coefficient for moving from the third to fourth

[72] That spouse employment in the public sector is statistically insignificant and relatively small in magnitude compared to the odds ratios for women also suggests that the old-age security rationale for fertility is not driving the impact of public sector work. Having either the husband or the wife in the public sector would secure such a pension.

birth is statistically significant (0.630), as was the case for the model without the fixed effects. The odds ratio for moving from the fourth to fifth birth is less than one, but insignificant, and the odds ratio for the fifth birth and above (1.112) is insignificant and is much smaller than in specification 3, where it was significant and very high (2.222).

Including women fixed-effects is likely to address many omitted variable problems but not necessarily issues of simultaneity and joint decision making, such as quitting a public sector job in order to have additional children. Therefore, an additional set of models are estimated for the impact of local public sector employment opportunities, rather than own public sector employment, on fertility.[73] It is important to note that local public sector employment opportunities are in percentage point terms, and so are on a different scale than the binary variable for women's own public sector employment. Figure 3.10 provides examples of the estimated variation in local employment opportunities over time for eight combinations of governorate and urban/rural. There is a substantial amount of variation in the estimated local employment opportunities over time. Although there is some consistency in overall trends, there are also clearly differences by location. For instance from 2002 to 2012 urban Giza had flat public sector employment rates around 10%, while from 2002 to 2012 urban Cairo had public sector employment rates that declined from 25% to 15%. This variation may be caused by where government jobs are allocated across a variety of different ministries and programs, such as the Social Fund for Development, which targets poor areas (with mixed success), or the national Youth Employment Program (Abou-Ali, El-Azony, El-Laithy, Haughton, & Khandker, 2010; De Gobbi & Nesporova, 2005).

These conditional logit models retain the women fixed effects and other covariates and are presented as specification 5 (in Table 3.5). Interacting public sector employment opportunities with births, there is a slightly higher odds ratio for moving from marriage to the first birth (1.012 for each percentage point increase in local public sector employment opportunities). There are lower odds ratios for moving on from the

[73] These are akin to reduced form instrumental variable models. The 2SRI models with women fixed effects were tested but generated implausible estimates. The 2SRI models without fixed effects are presented below.

first through fourth births, which are significant for the second to third birth (0.982), third to fourth birth (0.966) and fourth to fifth birth (0.960). For the highest order births, the odds ratio is 1.047 and statistically significant. This suggests that local employment opportunities are affecting women's fertility—potentially through their own employment. It is also quite likely that these effects are under-estimates, since although individuals' own reporting of employment status has relatively small measurement error, annual means for the 38 governorate and urban/rural combinations are based on finite samples and noisy. One additional concern with these estimates is whether the public sector local employment effect suffers from omitted variable bias.[74] The inclusion of additional time-varying local controls suggests that variation in health services and socio-economic characteristics, at least, is not driving the observed effects.

3.7.4 Discrete-Time Models of Fertility Using Instrumental Variables

As an alternative to using local employment opportunities as a reduced form instrument in the fixed-effects models, women's public sector employment can in fact be directly instrumented. If there is random measurement error in the local employment opportunities, this should not be a problem for estimates in the second stage of a two-stage instrumental variables framework. Table 3.6 presents the linear probability model for a woman working in the public sector in a given year, the first stage of the two-stage residual inclusion model. Public sector local employment opportunities are included in the current year, and lagged one and two years. Each percentage point increase in local opportunities increases the probability of a woman working in the public sector by 0.2% (p-value of 0.001). The one-year lag has a negative effect of 0.1% (p-value 0.068) and the two-year lag has a negative effect of less than 0.1% (p-value 0.615). The instruments together have a p-value of 0.002 and an F-statistic of 4.98. Thus, the instruments are

[74] Two additional checks of the robustness of the results based on local employment opportunities were undertaken. Models disaggregating male employment and female employment in the public sector, in case there was gender differentiation in jobs, showed similar effects for public sector work. Models with parity interacted public sector employment opportunities further interacted with education level were estimated as well. The impacts of local employment opportunities should be stronger for women with secondary and higher education. The coefficients provided only mixed evidence of a larger impact on the more educated and were noisy.

weak. Since controls for both year and location are included in the model, multi-collinearity may be an issue. Age and education are statistically significant and substantial predictors in this first stage.

In the second stage of the two-stage residual inclusion model, both the parity-interacted actual values of women's public sector employment and the parity-interacted residuals from the first stage are included in the equation. Table 3.7 presents the second stage discrete hazard logit model with bootstrapped standard errors. The standard errors around all of the public sector effects are large, and none of the public sector effects is statistically significant. However, the direction of the odds ratios is similar to the pattern in other models, suggesting that public sector work increases the probability of first births, decreases the probability of second, third, fourth, and fifth births, and after a fifth birth increases the probability of additional births.[75]

The residual interactions indicate that those who have unobservable characteristics, captured by the residual, that make them more likely to work in the public sector are in fact significantly more likely to progress from the second birth to the third, as well as to the fourth and fifth births. The plausibility of the unobservable characteristics that make women more likely to work in the public sector also causing higher fertility merits discussion. One explanation may be that couples with moderately conservative values about women's roles accept women working only in the public sector and also have higher fertility preferences, whereas couples with less conservative values accept women working in the private sector as well (and thus, women are somewhat less likely to work in the public sector). Observed relationships between socio-economic background and women's work provide suggestive evidence of this potential link (Assaad & Krafft, 2014). Overall, although the instruments are weak, the findings at least suggest that the results of models not accounting for endogeneity are likely to be under-estimates.

[75] A similar pattern was found when two-stage predictor substitution was used.

3.7.5 *Fertility Simulations*

Based on the various discrete-time hazard models estimated, it is possible to simulate total fertility rates for different profiles. Of specific interest is varying the impact of public sector employment. For a particular specification, profiles are identical except for variation in public sector employment, so that differences in TFRs within a specification are due to variation in public sector employment.[76]

For all of the simulations, other characteristics have to be selected. Time-varying local governorate characteristics are set to their mean, ages are increased by one group from 20-24 onwards for each parity in order to simulate an age progression, and the year is fixed at 2002. It is assumed that a male child will be born as the second child so that the dummy for having a male child equals zero for marriage to the first birth and the first birth to the second and equals one thereafter. In the fixed-effects models, results are estimated assuming the fixed effect is zero. In the 2SRI models, the residual is assumed to be zero.

For the models without fixed effects, a relatively typical profile of time-invariant characteristics is used: a vocational secondary educated female, with preparatory educated parents, born in urban Cairo. Vocational secondary graduates are a large group, 35% of women in the sample have attained a vocational secondary degree (Table 3.1), and also the group that has experienced the greatest decline in public sector employment over time (Assaad & Krafft, 2014). For all models, results are simulated over a full set of parity and birth interval interactions to estimate total fertility rates.

The first set of simulations estimates the impact of public sector work by comparing outcomes for these profiles while varying whether the woman is employed in the public sector. Own public sector employment is essentially set to 1 or 0 throughout a woman's entire fertility simulation. Figure 3.11 presents the results of these simulations. For the model incorporating a single public sector effect (specification 2), fertility is estimated to be 2.75 with a public sector job and 2.78 without a public sector job, a 0.03

[76] Simulating for profiles with different characteristics would generate different TFR levels and also some variation in differences between TFRs by public sector employment, since the log-odds for the hazards have an additive specification but resulting predicted hazards and simulated TFRs are not simply additive.

difference in childbearing. After fully interacting public sector work and parities (specification 3), the difference is larger, 0.11; fertility is predicted to be 2.68 with a public sector job and 2.79 without. In the parity-interacted fixed effect model (specification 4) fertility shifts from 2.70 for the public sector employee to 2.76 for a woman who is not employed in the public sector, an effect of approximately 0.06. For the 2SRI model, fertility shifts from 2.34 if a woman works in the public sector to 2.83 if she does not, a difference of 0.49.

Whether these differences in fertility are statistically significant can be assessed based on bootstrapped standard errors. None of the differences is statistically significant at $p<0.05$. The difference for specification 2 (single public sector effect) has a p-value of 0.585 and the difference for specification 3 (public sector interacted with parity) has a p-value of 0.080. The difference for specification 4 (public sector interacted with parity fixed effect model) has a p-value of 0.235. The difference for specification 6 (2SRI) has a p-value of 1.000. Overall, these potential differences in fertility are suggestive of changes in women's employment opportunities contributing to rising fertility. However, these changes are unlikely to be the sole driver in the shift from a 3.0 to 3.5 fertility rate recently in Egypt, especially since the change in public sector employment opportunities will have impacted only a fraction of women.

Simulating the impact of local employment opportunities on fertility shows a similar pattern (Figure 3.12). When public sector employment in the governorate and residence of birth is 10 percentage points above the mean (similar to the change over the period of study, see Figure 3.7) fertility in specification 5 is estimated at 2.81, while when simulating at the mean public sector employment rate fertility is 2.84, an 0.03 difference (the difference has a p-value of 0.239). This is suggestive of the potential impact of declining government employment on national fertility rates, and again indicates that public sector employment opportunities are likely contributing to the rise in fertility in Egypt, but are unlikely to be the sole factor driving trends. Comparing the results in Figure 3.11 and Figure 3.12 also indicates that the exact impact is uncertain, as it varies substantially across estimates. The estimation problems inherent to the various models may also be biasing estimates.

3.8 Discussion and Conclusions

This study contributes important evidence that fertility is on the rise in Egypt. While fertility had been decreasing relatively steadily over time, reaching a low of a 3.0 TFR in 2008, this study demonstrates that fertility in Egypt has risen to 3.5 as of 2012, a pattern continuing in 2014 (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). Thus, Egypt appears to be reversing its demographic transition, a phenomenon with concerning implications for its society and economy. It is likely that a variety of different factors are contributing to the rise in fertility, but one potential cause, and the focus of this essay, is the decline in employment opportunities for women, specifically in the public sector.

In order to test the relationship between fertility and employment opportunities, this essay united the literature on using duration analysis models for fertility simulations (Retherford, Ogawa, Matsukura, & Eini-Zinab, 2010; Van Hook & Altman, 2013) with the literature on addressing endogeneity using fixed-effects in discrete-time duration models (Allison, 2009) and instrumental variables in inherently non-linear settings (Terza, Basu, & Rathouz, 2008; Wooldridge, 2015). Public sector employment was found to be particularly important at the margin of going on from a third to a fourth birth in the logit models. A similar pattern was found in the conditional logit (women fixed effects) models. The impact of local employment opportunities, which are beyond women's control and thus avoid potential issues of simultaneity or reverse causality, further suggested an important relationship between public sector employment opportunities and women's fertility. Instrumental variable estimates, although suffering from weak instruments and statistical insignificance, suggest that other methods are under-estimates. Overall, the evidence presented in this essay suggests that declining opportunities for women can have an effect on fertility, but are unlikely to be the sole driver of recent fertility increases in Egypt.

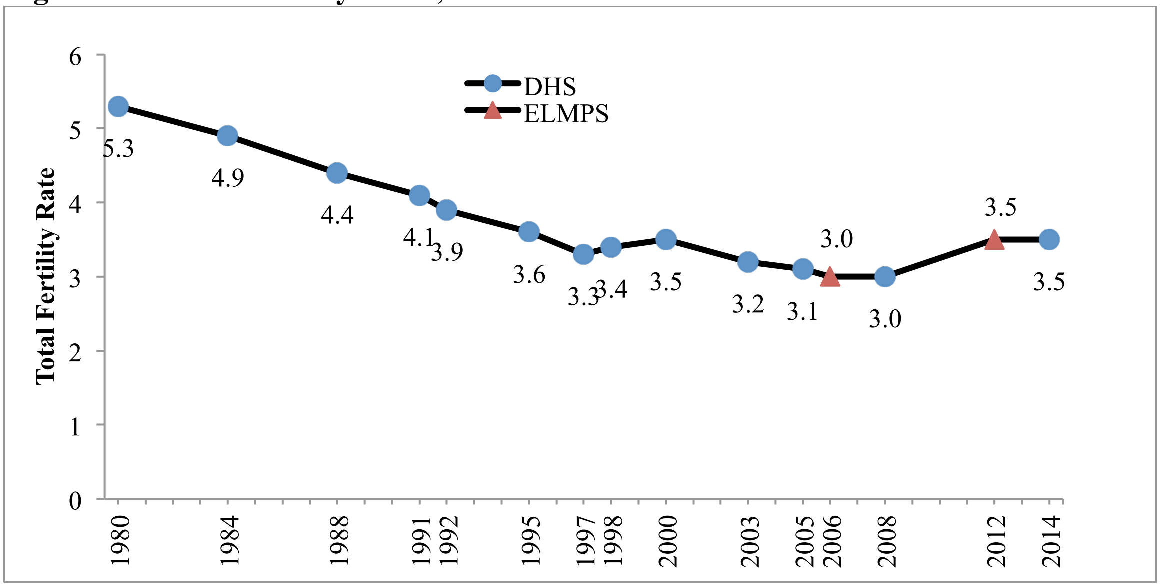
This study is one of the few to investigate the impact of economic opportunities for women on their childbearing. The findings suggest that labor market opportunities, and especially the type of jobs available to women, impact fertility. Traditionally, declining economic opportunities (i.e. recessions) are associated with declines in fertility (Sobotka, Skirbekk, & Philipov, 2011). However, this research indicates that economic opportunities may interact with gender. This finding also extends the literature on the potentially offsetting impacts of price and income effects from changing economic opportunities on childbearing (Schultz, 1997). These relationships are typically empirically estimated as how rising wages and increasing opportunities for women can decrease fertility (Fang, Eggleston, Rizzo, & Zeckhauser, 2013; Galor & Weil, 1996; Heckman & Walker, 1990; Jensen, 2012; Mukhopadhyay, 1994; Rosenzweig & Evenson, 1977; Schultz, 1985). This essay examines the opposite case. Specifically, as economic opportunities that are particularly appealing to women decline and opportunities that are less appealing increase, so that the value of market work is substantially reduced, women may substitute into childbearing.

The rise in fertility in Egypt is likely to be the result of a multitude of forces, but this essay's findings indicate that the changing economic structure is a contributing factor to the rise in fertility. This impact is an unintended consequence of the attempt to shift from a public-sector led model of employment to a private-sector, market-oriented paradigm. In the wake of structural reform and reductions in the government wage bill and government employment, women have fewer employment opportunities. This is due in part to the failure of the private sector to replace public sector jobs with high-quality, formal private sector jobs with protections and benefits (Assaad & Krafft, 2015c; Gatti, Angel-Urdinola, Silva, & Bodor, 2014). Women choose to leave (or never enter) the labor force rather than undertake the informal jobs that are available (Amer, 2015; Assaad & Krafft, 2014, 2015c; Hendy, 2015). This paradigm could potentially be changed with appropriate labor market reforms (Assaad & Krafft, 2014; Krafft & Assaad, 2015).

Whether Egypt can successfully integrate women into the labor force and again progress in its demographic transition is a question with crucial implications for Egypt's society and economy. The pressures of the youth bulge on institutions such as the education system and labor market were severe (Assaad & Krafft, 2015a; Elbadawy, 2015; Youssef, Osman, & Roudi-Fahimi, 2014). The "echo" of the youth bulge resulting from the youth bulge forming families along with higher fertility rates is sure to again place pressures on health and education systems as well as on the labor market (Krafft & Assaad, 2014). These findings also have important implications for global population policies and labor markets; increasing access to employment for women and closing wage gaps may be an important part of other countries completing their fertility transitions.

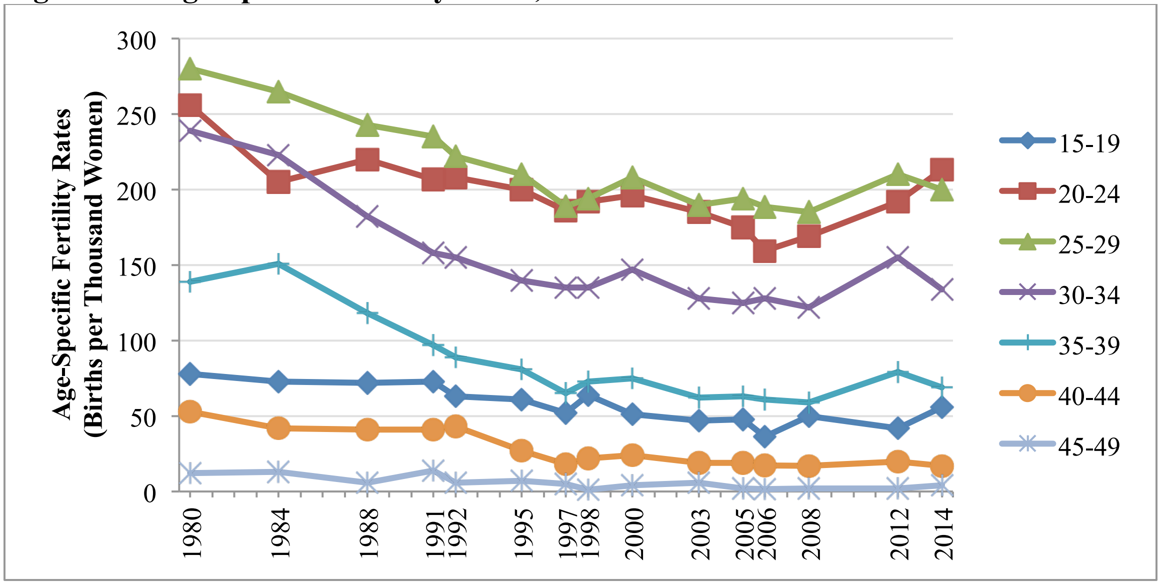
Figures

Figure 3.1. Total Fertility Rates, 1980-2014



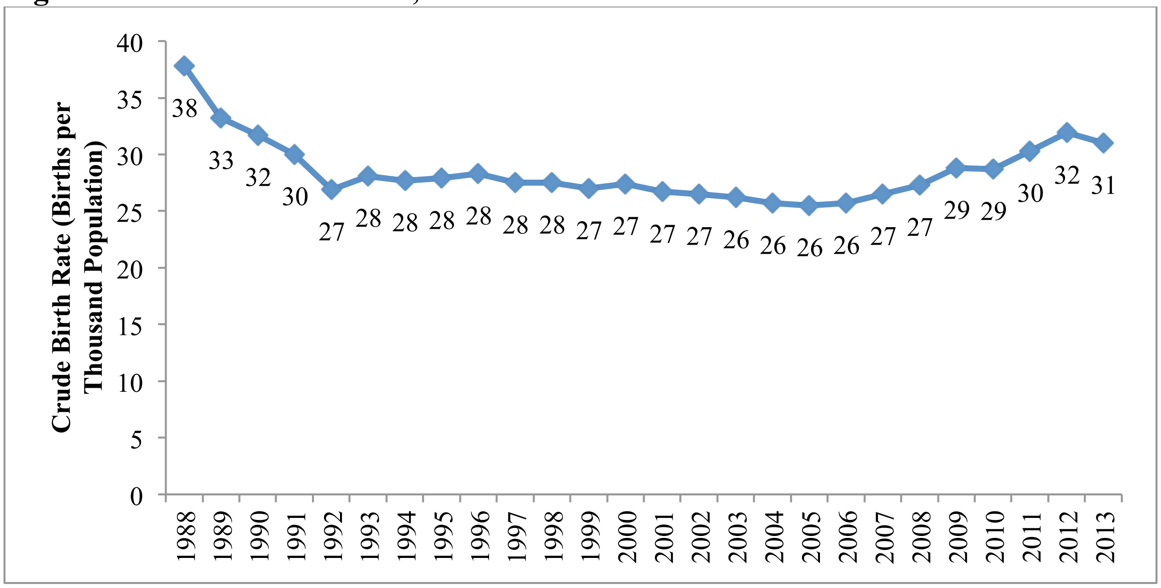
Notes: TFRs for 1980, 1984, and 1991 are 12 months preceding the survey. TFRs for 2012 and 2006 are three years preceding the survey, remainder are 1-36 months preceding the survey.
Source: TFRs for 1980-2005 and 2008 are from El-Zanaty & Way (2009) and are primarily Demographic and Health Survey statistics. TFR for 2014 is from the 2014 Demographic and Health Survey (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). TFRs for 2012 and 2006 based on author's calculations from the ELMPS 2012 and ELMPS 2006.

Figure 3.2. Age-Specific Fertility Rates, 1980-2014



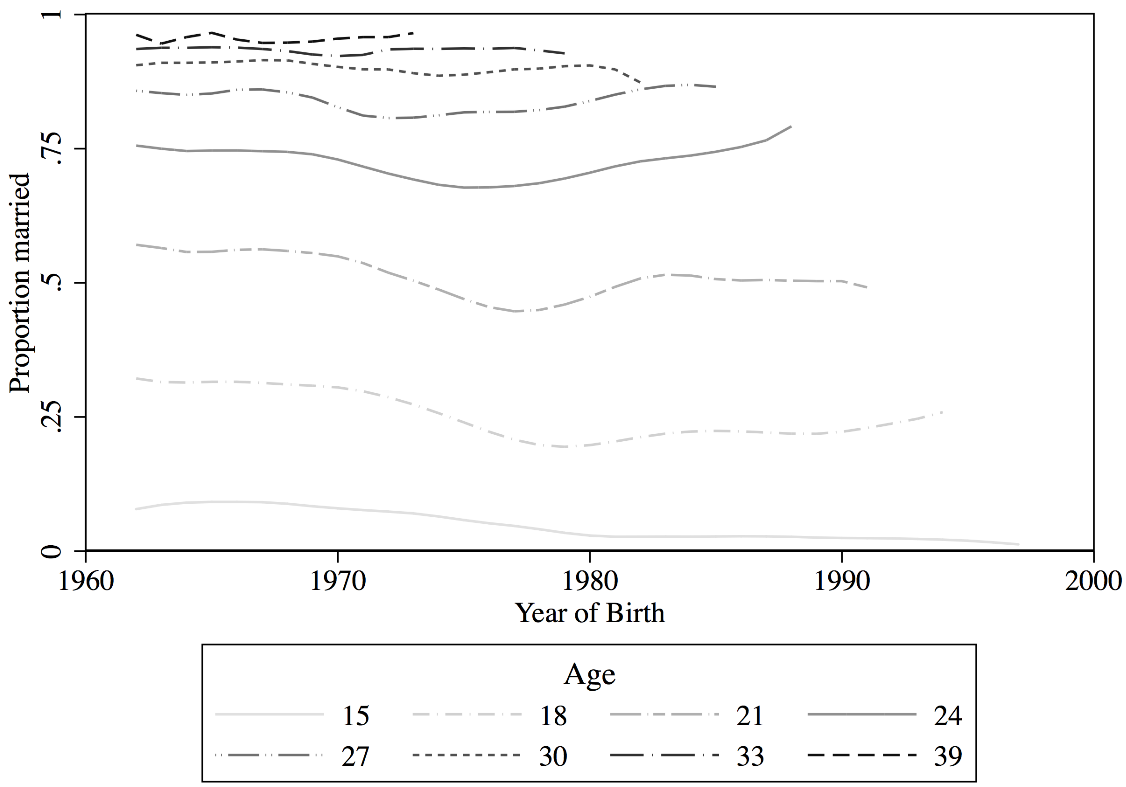
Notes: ASFRs for 1980, 1984, and 1991 are 12 months preceding the survey. ASFRs for 2012 and 2006 are three years preceding the survey, remainder are 1-36 months preceding the survey.
Source: ASFRs for 1980-2005 and 2008 are from El-Zanaty & Way (2009) and are primarily Demographic and Health Survey statistics. ASFR for 2014 is from the 2014 Demographic and Health Survey (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). ASFRs for 2012 and 2006 based on author's calculations from the ELMPS 2012 and ELMPS 2006.

Figure 3.3. Crude Birth Rates, 1988-2013



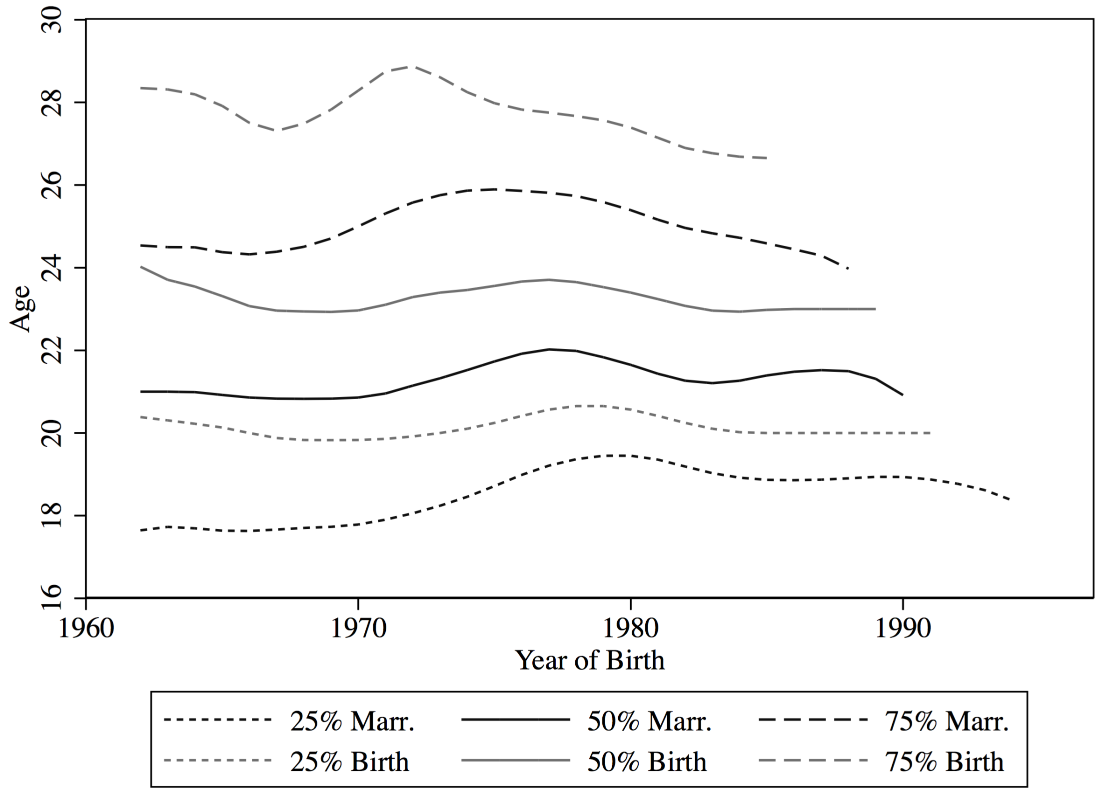
Source: Central Agency for Public Mobilization and Statistics (2015).

Figure 3.4. Proportion of Women Married by Various Ages by Women's Year of Birth



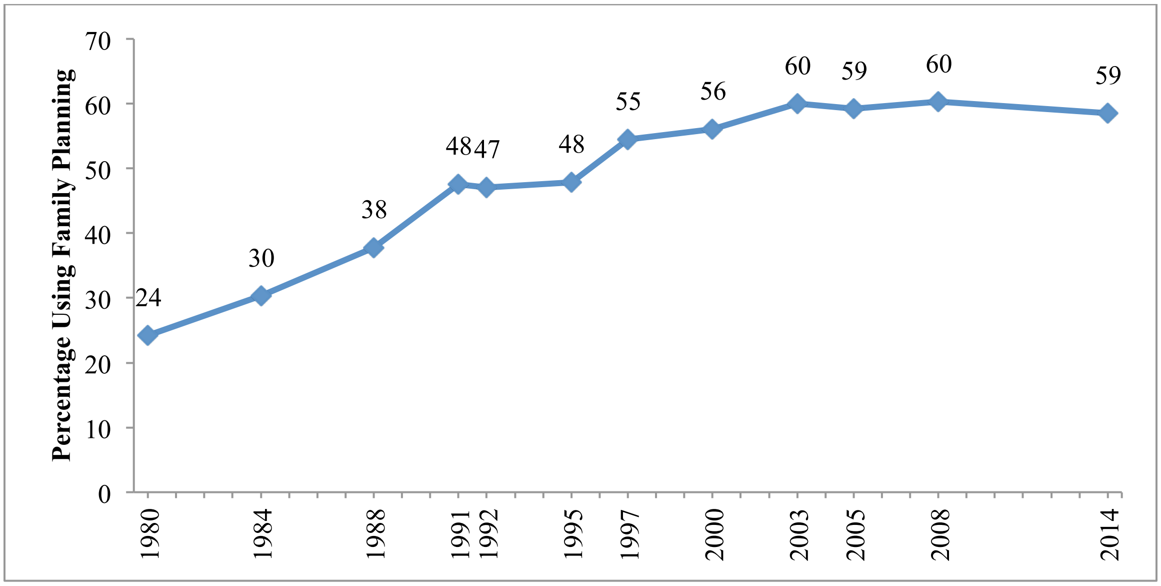
Notes: Lowess smoothed, bandwidth 0.4.
Source: Author's calculations based on ELMPS 2012.

Figure 3.5. 25th, 50th, and 75th Percentiles for Age at Marriage and Age at First Birth by Women's Year of Birth



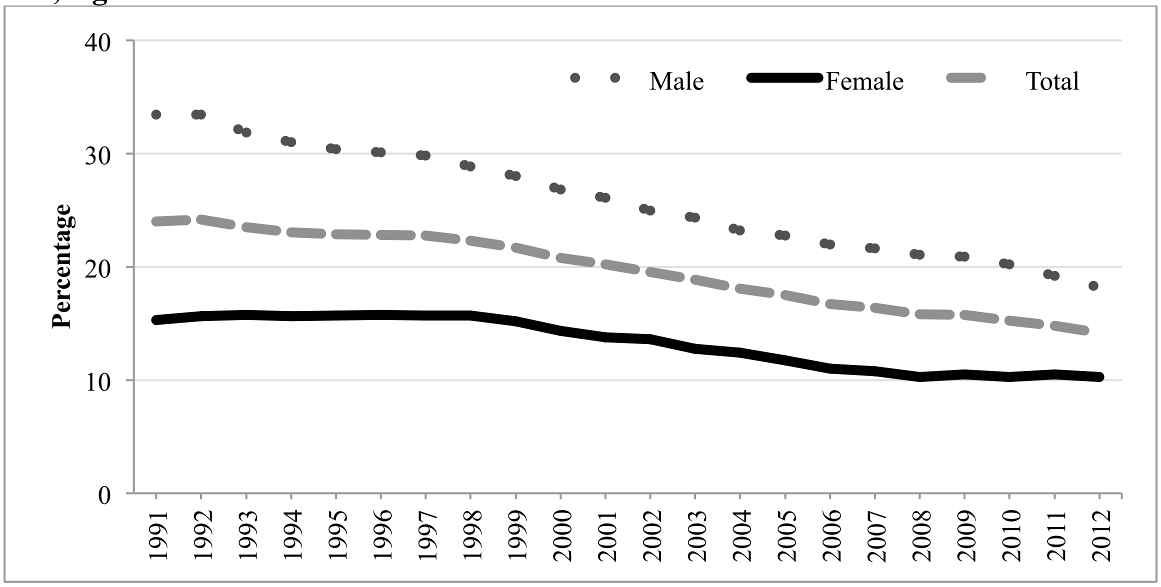
Notes: Lowess smoothed, bandwidth 0.4.
Source: Author's calculations based on ELMPS 2012.

Figure 3.6. Percentage of Currently Married Women Using Family Planning, Ages 15-49



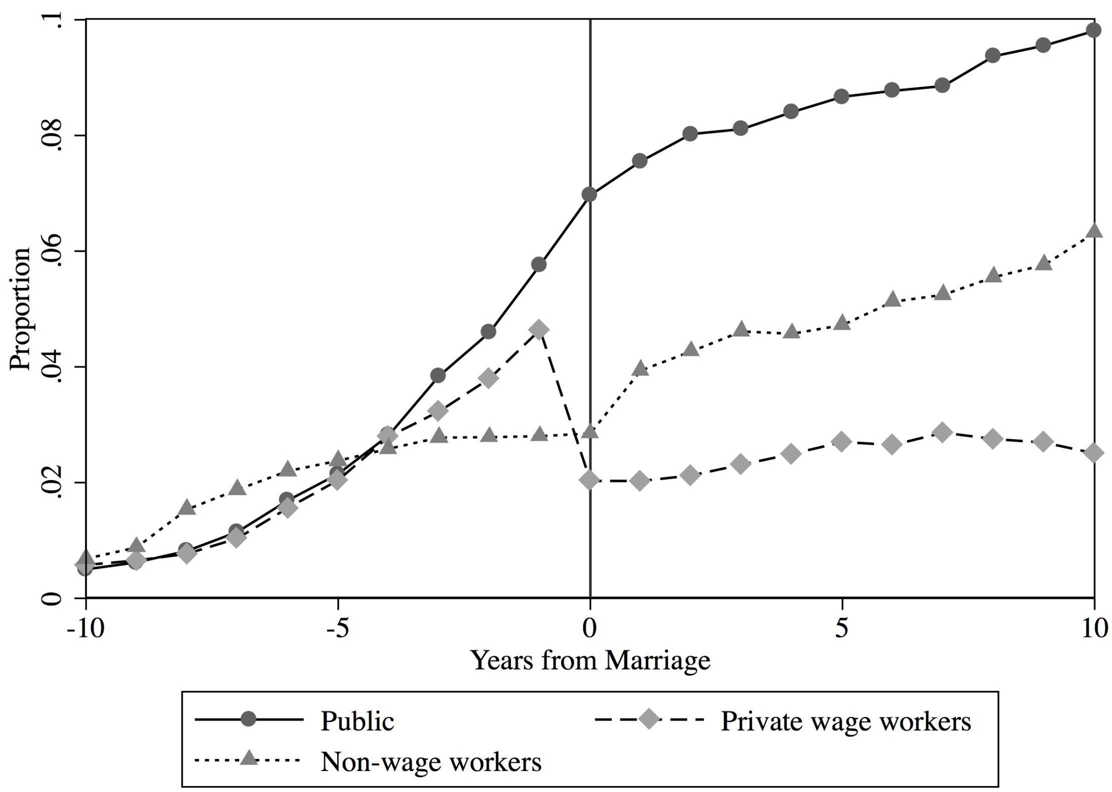
Source: DHS surveys for Egypt (El-Zanaty & Way, 2009; Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015).

Figure 3.7. Percentage of Population Employed in the Public Sector over Time by Sex, Ages 25-39



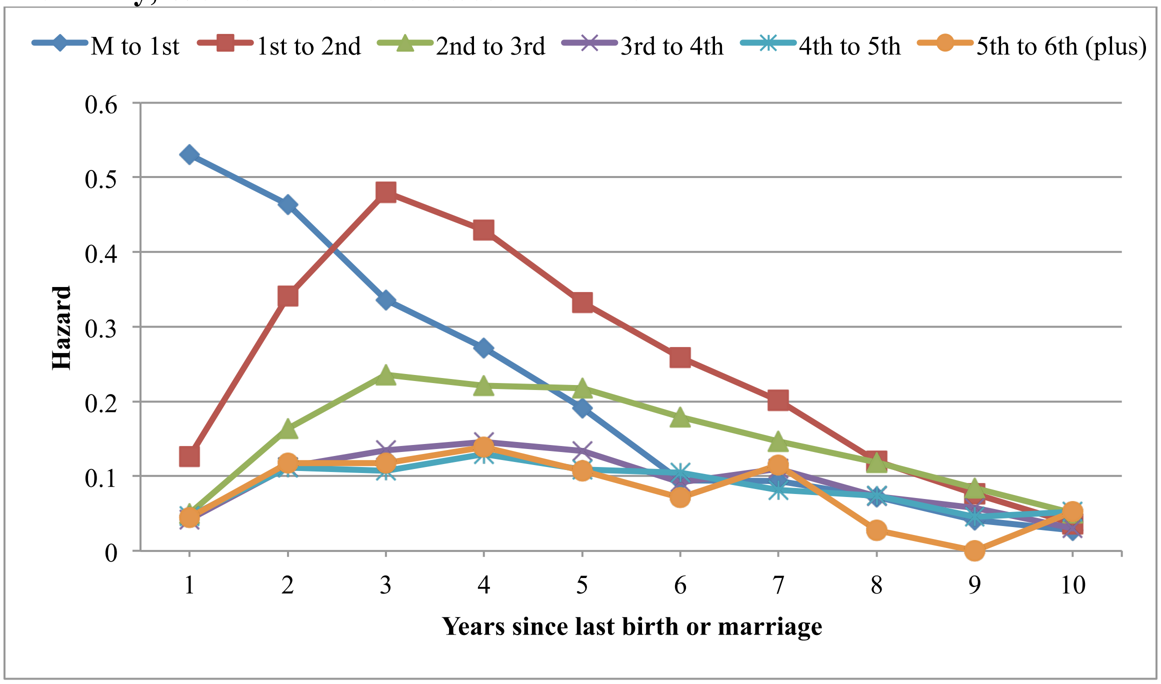
Source: Author's calculations based on ELMPS 2012.
Note: Age 25-39 sample is for the year in question, not necessarily the age in 2012.

Figure 3.8. Proportion of Women in Public Sector, Private Sector Wage, and Non-Wage Work by Years from Marriage, Women Married between 1992-2002



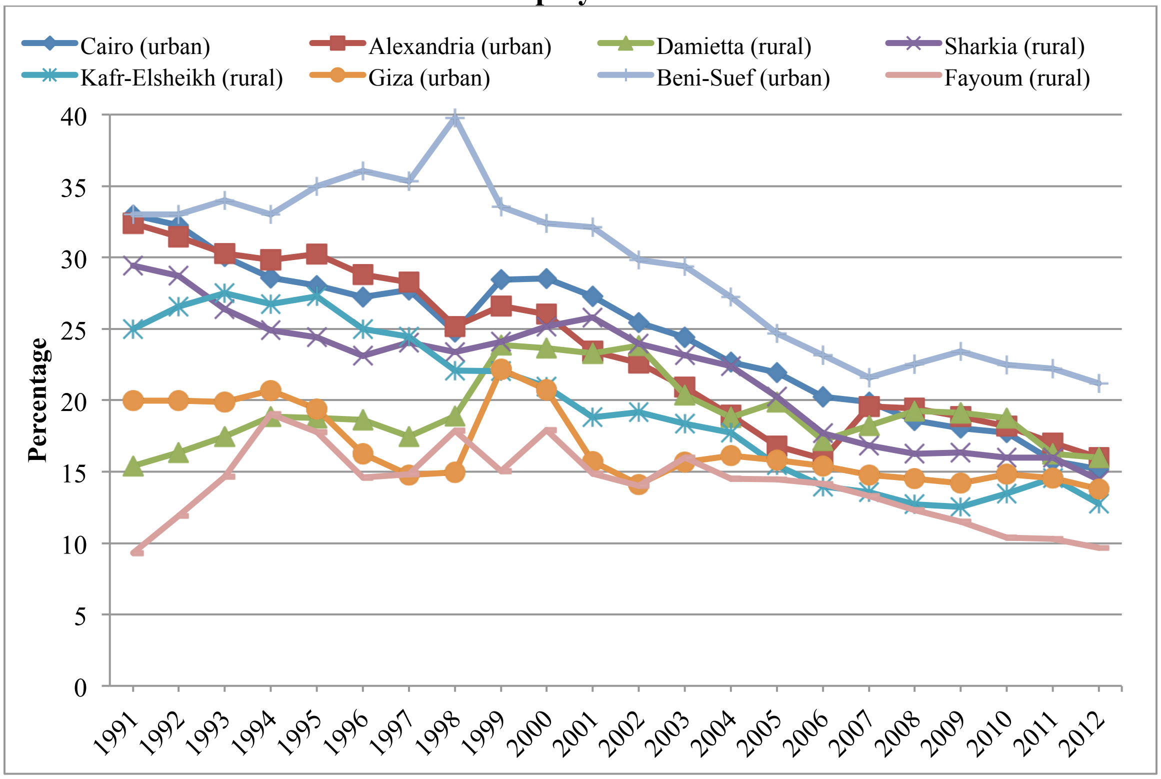
Source: Author's calculations based on ELMPS 2012.

Figure 3.9. **Baseline Hazard of Next Birth by Years Since Last Birth or Marriage and Parity, Women Married between 1991 and 2011**



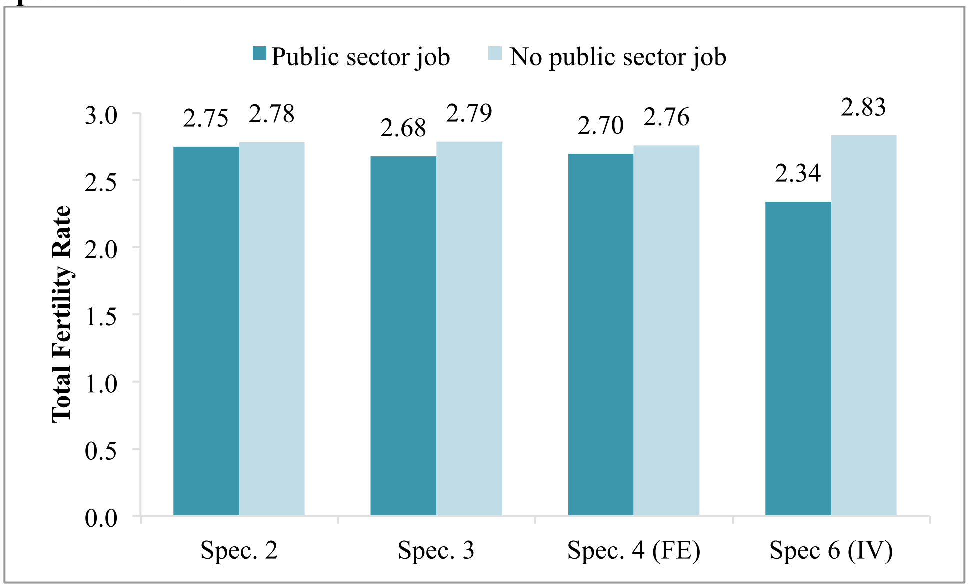
Source: Author's calculations based on ELMPS 2012.
Notes: Based on discrete-time hazard (logit) model with no additional covariates.

Figure 3.10. Example Urban/rural and Governorate Level Trends in Percentage of 25-39 Year-olds with Public Sector Employment



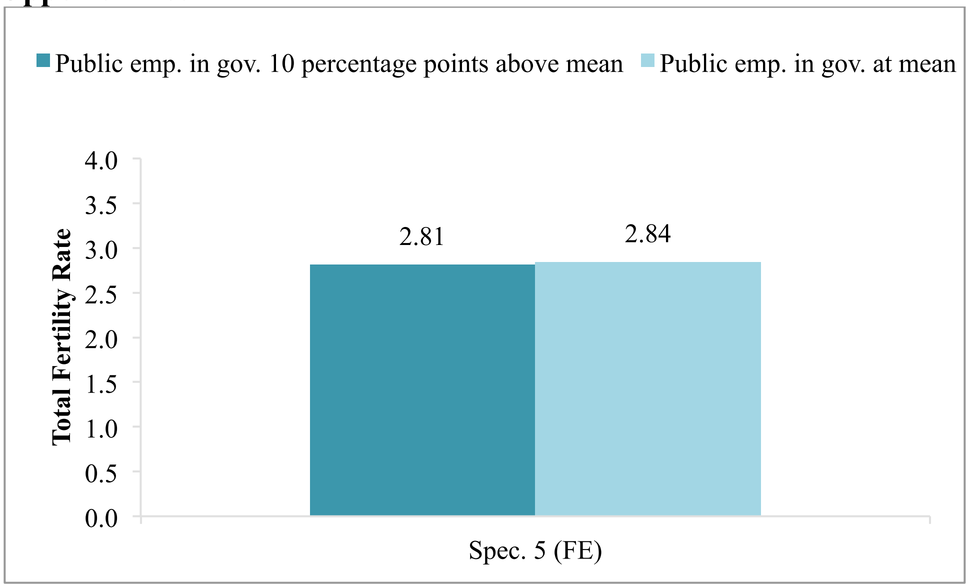
Source: Author's calculations based on ELMS 1998, ELMPS 2006, and ELMPS 2012.
Note: Age 25-39 sample is for the year in question, not necessarily the age in survey year.

Figure 3.11. Simulations of Fertility by Public Sector Employment across Specifications



Source: Author's calculations.
Notes: Based on discrete-time hazard models (logits and conditional logits (based on models in Table 3.3, Table 3.5, and Table 3.7).

Figure 3.12. Simulations of Fertility by Local Public Sector Employment Opportunities



Source: Author's calculations.
Notes: Based on discrete-time hazard models (conditional logits (based on model in Table 3.5).

Tables

Table 3.1. Sample Characteristics

An observation is woman-parity-years since last birth

	Percentage
Woman's educational attainment	
Illiterate (reference)	28.0
Read & write	2.8
Primary	8.4
Preparatory	6.4
General secondary	2.0
Vocational secondary	35.2
Post-secondary inst.	3.5
University & above	13.8
Mother's level of education attained	
Illiterate (reference)	80.8
Read & write	8.2
Less than secondary	5.4
Secondary	3.6
Post-secondary inst.	0.5
University & above	1.5
Father's level of education attained	
Illiterate (reference)	55.3
Read & write	19.6
Less than secondary	11.5
Secondary	7.5
Post-secondary inst.	1.3
University & above	4.6
Woman's residence at birth	
Urban (reference)	40.1
Rural	59.9
Woman's governorate at birth	
Cairo (reference)	11.4
Alexandria	4.9
Port-Said	0.5
Suez	0.8
Damietta	3.1
Dakahlia	6.0
Sharkia	7.2
Kalyoubia	5.8
Kafr-Elsheikh	5.6

Gharbia	6.1	
Menoufia	3.8	
Behera	6.2	
Ismailia	3.4	
Giza	5.0	
Beni-Suef	4.0	
Fayoum	3.7	
Menia	5.4	
Asyout	4.5	
Suhag	5.2	
Qena	4.9	
Aswan	2.5	
Have a son		
Not yet (reference)	43.8	
Yes	56.2	
Public sector employment		
No (reference)	90.3	
Yes	9.7	
Total	100.0	

	Mean	**Standard Deviation**
Governorate characteristics		
Public employment rate	18.5	6.5
Life expectancy (years)	70.4	2.3
Adult literacy rate (percentage)	68.8	12.1
GDP per capita (in thousands of 2012 LE)	14.7	3.8
Prenatal care (percentage)	71.3	16.7
N	65781	

Source: Author's calculations.

Table 3.2. Total Fertility Rate by Women's Characteristics in 2006 and 2012

	TFR 2006	TFR 2012	Percentage 2006	Percentage 2012
Ever worked in public sector				
No	3.0	3.5	89.6	88.9
Yes	2.6	3.2	10.4	11.1
Educational attainment				
Illiterate	3.5	4.0	32.2	25.1
Read & write	3.0	3.0	3.6	2.5
Primary	3.0	3.7	6.9	8.0
Preparatory	3.2	3.5	8.3	10.6
General secondary	2.1	3.2	6.2	6.8
Vocational secondary	3.1	3.9	28.0	28.7
Post-secondary inst.	2.7	2.9	3.8	3.1
University & above	2.7	3.2	10.9	15.2
Urban/Rural				
Urban	2.6	3.2	43.7	42.8
Rural	3.2	3.7	56.3	57.2
Region				
Greater Cairo	2.6	3.1	13.2	18.0
Alexandria & Suez Canal	2.5	2.8	8.1	7.9
Urban Lower	2.7	3.4	10.5	9.9
Urban Upper	2.6	3.5	11.9	7.2
Rural Lower	2.9	3.5	32.0	31.7
Rural Upper	3.6	4.0	24.3	25.2
Quintiles of household wealth				
Poorest	3.1	3.9	18.8	17.9
Second	3.2	3.5	20.7	20.4
Third	3.0	3.6	20.8	21.1
Fourth	2.9	3.6	19.7	20.6
Richest	2.5	2.9	20.0	20.0
Mother's level of education				
Illiterate	3.1	3.8	75.5	73.1
Read & write	3.1	3.6	8.9	7.0
Less than secondary	2.6	2.6	6.4	7.5
Secondary	2.6	3.1	5.7	7.8
Post-secondary inst.	2.5	3.4	0.9	0.9
University & above	1.9	3.4	2.5	3.6
Father's level of education				
Illiterate	3.1	3.8	49.6	50.7
Read & write	3.3	3.8	22.7	16.7
Less than secondary	2.6	3.1	11.2	12.5
Secondary	2.8	3.5	8.1	10.5
Post-secondary inst.	3.0	2.8	1.9	1.8
University & above	2.3	2.7	6.5	7.8
Total	3.0	3.5	100.0	100.0

Source: Author's calculations based on ELMPS 2012 and ELMPS 2006.
Note: Because public sector workers are required to have a secondary degree (i.e. be at least 18), the ASFR for the 15-19 age group was inestimable for those who worked in the public sector and treated as zero.

Table 3.3. Discrete-Time Survival Analysis Models (Logit) for Births
Dependent Variable: Probability (in year) of a birth.
Coefficients have been transformed into odds ratios. Standard errors in parentheses.

	Spec. 1	Spec. 2	Spec. 3
Working in public sector	0.810***	0.976	
	(0.033)	(0.045)	
Public sector work interacted with parity			
Marriage			1.060
			(0.073)
First birth			1.046
			(0.076)
Second birth			0.863
			(0.071)
Third birth			0.686*
			(0.102)
Fourth birth			1.125
			(0.228)
Fifth birth and above			2.222**
			(0.615)
Age group			
<20		1.155**	1.162**
		(0.064)	(0.064)
20-24		1.498***	1.499***
		(0.064)	(0.063)
25-29		1.372***	1.363***
		(0.049)	(0.048)
35-39		0.575***	0.578***
		(0.032)	(0.033)
40-44		0.207***	0.205***
		(0.026)	(0.027)
45-49		0.025***	0.024***
		(0.014)	(0.014)
Have a male child (not yet omitted)			
Yes		0.751***	0.751***
		(0.023)	(0.023)
Education (illit. omit)			
Read and write		0.991	0.989
		(0.062)	(0.062)
Primary		0.867**	0.866**
		(0.040)	(0.040)
Preparatory		0.926	0.925
		(0.050)	(0.050)
General secondary		1.060	1.064
		(0.088)	(0.089)
Vocational secondary		0.989	0.990
		(0.030)	(0.031)
Post-sec. inst.		1.033	1.036
		(0.063)	(0.064)
University & above		1.157**	1.163**

	Spec. 1	Spec. 2	Spec. 3
		(0.053)	(0.054)
Mother's ed. (illit. omit)			
Read and write		1.035	1.032
		(0.042)	(0.042)
Less than secondary		0.917	0.914
		(0.046)	(0.046)
Secondary		0.905	0.900
		(0.055)	(0.055)
Post-sec. inst.		0.815	0.809
		(0.129)	(0.129)
University & above		0.777**	0.771**
		(0.072)	(0.072)
Father's ed. (illit. omit)			
Read and write		0.990	0.990
		(0.030)	(0.030)
Less than secondary		0.952	0.953
		(0.036)	(0.036)
Secondary		0.995	0.997
		(0.046)	(0.047)
Post-sec. inst.		0.800*	0.802*
		(0.071)	(0.071)
University & above		0.842**	0.839**
		(0.056)	(0.057)
Governorate chars.			
Life expectancy (years)		0.995	0.996
		(0.029)	(0.029)
Adult lit.		1.003	1.004
		(0.004)	(0.004)
GDP per capita (thousand LE)		0.997	0.996
		(0.005)	(0.005)
Prenatal care		1.000	1.000
		(0.002)	(0.002)
Parity and yrs. since last birth	Yes	Yes	Yes
Birth gov. and urban/rural	No	Yes	Yes
Year dummies	No	Yes	Yes
N	65763	65399	65399

Source: Author's calculations.
Notes: *p<0.05 **p<0.01 ***p<0.001
Standard errors clustered at PSU level.

Table 3.4. Discrete-Time Survival Analysis Model (Logit) for Births Including Spouse Characteristics

Dependent Variable: Probability (in year) of a birth.

Coefficients have been transformed into odds ratios. Standard errors in parentheses.

Public sector work interacted with parity	
Marriage	1.028
	(0.077)
First birth	1.066
	(0.086)
Second birth	0.868
	(0.076)
Third birth	0.691*
	(0.113)
Fourth birth	1.430
	(0.329)
Fifth birth and above	1.646
	(0.560)
Age group	
<20	1.077
	(0.068)
20-24	1.354***
	(0.063)
25-29	1.256***
	(0.049)
35-39	0.624***
	(0.040)
40-44	0.261***
	(0.036)
45-49	0.039***
	(0.022)
Have a male child (not yet omitted)	
Yes	0.748***
	(0.023)
Education (illit. omit)	
Read and write	1.006
	(0.069)
Primary	0.859**
	(0.044)
Preparatory	0.933
	(0.052)
General secondary	1.036
	(0.098)
Vocational secondary	0.992
	(0.039)
Post-sec. inst.	1.001
	(0.070)
University & above	1.125*
	(0.066)
Mother's ed. (illit. omit)	
Read and write	1.007

	(0.044)
Less than secondary	0.956
	(0.053)
Secondary	0.862*
	(0.054)
Post-sec. inst.	0.721
	(0.122)
University & above	0.762*
	(0.081)
Father's ed. (illit. omit)	
Read and write	1.004
	(0.032)
Less than secondary	0.993
	(0.039)
Secondary	0.986
	(0.048)
Post-sec. inst.	0.825*
	(0.078)
University & above	0.870*
	(0.062)
Spouse public sector work interacted with parity	
Marriage	1.041
	(0.056)
First birth	1.024
	(0.055)
Second birth	0.940
	(0.051)
Third birth	1.000
	(0.081)
Fourth birth	0.794
	(0.118)
Fifth birth and above	1.231
	(0.306)
Spouse education (illit. omit)	
Read and write	1.104
	(0.065)
Primary	0.952
	(0.041)
Preparatory	0.917
	(0.054)
General secondary	0.870
	(0.079)
Vocational secondary	0.955
	(0.039)
Post-sec. inst.	0.886
	(0.056)
University & above	1.016
	(0.052)
Spouse age group (30-34 omit.)	

<20	0.619*
	(0.118)
20-24	0.967
	(0.048)
25-29	1.066*
	(0.033)
35-39	0.934*
	(0.031)
40-44	0.856**
	(0.042)
45-49	0.616***
	(0.044)
Governorate chars.	
Life expectancy (years)	0.993
	(0.031)
Adult lit.	1.004
	(0.004)
GDP per capita (thousand LE)	0.992
	(0.005)
Prenatal care	0.999
	(0.002)
Parity and yrs. since last birth	Yes
Birth gov. and urban/rural	Yes
Year dummies	Yes
N	56945

Source: Author's calculations.
Notes: *p<0.05 **p<0.01 ***p<0.001
Standard errors clustered at PSU level.
Only for sub-sample of women with husbands present in the household.

Table 3.5. Discrete-Time Survival Analysis Models with Women Fixed Effects (Conditional Logit) for Births

Dependent Variable: Probability (in year) of a birth.

Coefficients have been transformed into odds ratios. Standard errors in parentheses.

	Spec. 4	Spec. 5
Public sector emp. interacted with parity		
Marriage	1.162	
	(0.200)	
First birth	1.090	
	(0.166)	
Second birth	0.868	
	(0.131)	
Third birth	0.630*	
	(0.123)	
Fourth birth	0.768	
	(0.236)	
Fifth birth and above	1.112	
	(0.520)	
Public sector local emp. (percentage) interacted with parity		
Marriage		1.012*
		(0.006)
First birth		0.998
		(0.005)
Second birth		0.982**
		(0.006)
Third birth		0.966***
		(0.008)
Fourth birth		0.960**
		(0.013)
Fifth birth and above		1.047*
		(0.023)
Age group		
<20	0.576***	0.572***
	(0.075)	(0.074)
20-24	1.002	0.988
	(0.091)	(0.089)
25-29	1.254***	1.251***
	(0.071)	(0.071)
35-39	0.490***	0.483***
	(0.037)	(0.036)
40-44	0.119***	0.115***
	(0.020)	(0.019)
45-49	0.008***	0.007***
	(0.006)	(0.005)
Have a male child (not yet omitted)		
Yes	0.548***	0.548***
	(0.027)	(0.027)
Governorate chars.		

	Spec. 4	Spec. 5
Life expectancy (years)	1.206***	1.195***
	(0.046)	(0.046)
Adult lit.	1.022***	1.019***
	(0.005)	(0.005)
GDP per capita (thousand LE)	1.012	1.011
	(0.007)	(0.007)
Prenatal care	1.000	1.000
	(0.003)	(0.003)
Parity and yrs. since last birth	Yes	Yes
Year dummies	Yes	Yes
N	60673	60673

Source: Author's calculations.
Notes: *p<0.05 **p<0.01 ***p<0.001
Standard errors clustered at woman level.

Table 3.6. Linear Probability Model (First Stage) for Employment in Public Sector in Year

Dependent Variable: Probability (in year) of public sector employment.

Public sector local emp. (percentage)	
In current year	0.002***
	(0.001)
One year lag	-0.001
	(0.000)
Two year lag	-0.000
	(0.000)
Age group (30-34 omit.)	
<20	-0.079***
	(0.006)
20-24	-0.092***
	(0.006)
25-29	-0.052***
	(0.004)
35-39	0.061***
	(0.006)
40-44	0.148***
	(0.015)
45-49	0.226***
	(0.029)
Education (illit. omit)	
Read and write	0.023***
	(0.007)
Primary	0.024***
	(0.006)
Preparatory	0.030***
	(0.007)
General secondary	0.145***
	(0.028)
Vocational secondary	0.109***
	(0.009)
Post-sec. inst.	0.209***
	(0.028)
University & above	0.353***
	(0.017)
Mother's ed. (illit. omit)	
Read and write	0.008
	(0.015)
Less than secondary	0.003
	(0.019)
Secondary	0.025
	(0.028)
Post-sec. inst.	0.020
	(0.072)
University & above	-0.001
	(0.046)

Father's ed. (illit. omit)	
Read and write	0.010
	(0.009)
Less than secondary	0.023
	(0.014)
Secondary	0.017
	(0.018)
Post-sec. inst.	0.014
	(0.036)
University & above	0.017
	(0.029)
Governorate chars.	
Life expectancy (years)	0.009*
	(0.005)
Adult lit.	-0.000
	(0.001)
GDP per capita (thousand LE)	0.001*
	(0.001)
Prenatal care	-0.000
	(0.000)
Constant	-0.103***
	(0.019)
Year dummies	Yes
Birth gov. and urban/rural	Yes
N	64787
R-squared	.227

Source: Author’s calculations.
Notes: *p<0.05 **p<0.01 ***p<0.001
Standard errors clustered at PSU level.

Table 3.7. Two-Stage Residual Inclusion Discrete-Time Survival Analysis Model (Second Stage Logit) for Births

Dependent Variable: Probability (in year) of a birth.
Coefficients are odds ratios. Bootstrapped standard errors in parentheses.

Public sector work interacted with parity	
Marriage	1.145
	(4.771)
First birth	0.918
	(3.832)
Second birth	0.497
	(2.056)
Third birth	0.259
	(1.087)
Fourth birth	0.381
	(1.631)
Fifth birth and above	3.109
	(14.029)
Residual for public sector work interacted with parity	
Marriage	0.895
	(3.726)
First birth	1.247
	(0.326)
Second birth	2.076*
	(0.735)
Third birth	3.602**
	(1.622)
Fourth birth	4.248*
	(3.074)
Fifth birth and above	0.610
	(0.773)
Age group (30-34 omit.)	
<20	1.150
	(0.383)
20-24	1.438
	(0.556)
25-29	1.305
	(0.292)
35-39	0.600
	(0.160)
40-44	0.221*
	(0.137)
45-49	0.025**
	(0.029)
Have a male child (not yet omitted)	
Yes	0.752***
	(0.024)
Education (illit. omit)	
Read and write	0.999
	(0.128)

Primary	0.873
	(0.096)
Preparatory	0.940
	(0.125)
General secondary	1.114
	(0.725)
Vocational secondary	1.027
	(0.466)
Post-sec. inst.	1.102
	(1.002)
University & above	1.260
	(1.847)
Mother's ed. (illit. omit)	
Read and write	1.025
	(0.080)
Less than secondary	0.910
	(0.090)
Secondary	0.891
	(0.138)
Post-sec. inst.	0.805
	(0.249)
University & above	0.757
	(0.204)
Father's ed. (illit. omit)	
Read and write	0.992
	(0.060)
Less than secondary	0.953
	(0.104)
Secondary	1.018
	(0.138)
Post-sec. inst.	0.799
	(0.174)
University & above	0.840
	(0.174)
Governorate chars.	
Life expectancy (years)	0.969
	(0.051)
Adult lit.	1.004
	(0.005)
GDP per capita (thousand LE)	0.998
	(0.010)
Prenatal care	1.000
	(0.003)
Parity and yrs. since last birth	Yes
Birth gov. and urban/rural	Yes
Year dummies	Yes
N	64769

Source: Author’s calculations.
Notes: *p<0.05 **p<0.01 ***p<0.001
Bootstrapping undertaken with clustering on the PSU level.

Chapter 4

4 The Determinants of Child Health Disparities in Jordan

4.1 Introduction

The first few years of children's lives provide a crucial window for human development. Faltering growth and development in the early years are difficult to reverse. Early missteps in human development have far-reaching consequences for children's human capital, affecting later development potential, school success, labor market outcomes, and adult health. Early childhood[77] is also the period when inequality originates and the intergenerational transmission of poverty begins. When children suffer from malnutrition in the early years, it damages their psycho-social development (Dercon & Sánchez, 2013), causes poorer school performance (Glewwe & Miguel, 2008), impairs adult health (Victora, Adair, Fall, et al., 2008), and ultimately lowers wages (Grantham-McGregor, Cheung, Cueto, et al., 2007). It is therefore of paramount importance to identify the causes of poor early health and nutrition, and to understand what drives inequality in early health and nutrition, in order to provide children with equal chances for healthy growth.

The specific focus of this essay is identifying the mechanisms that mediate socio-economic inequalities in height and weight in Jordan. Essentially, this essay quantifies inequality, first as it relates solely to socio-economic status (parental education, employment, and wealth) and then with the addition of a number of other factors, such as feeding practices, that might be mechanisms through which socio-economic inequality occurs. Comparing inequality across these specifications allows for an assessment of the

[77] The term "early childhood" lacks a single clear definition in the literature. The margins of early childhood are uncertain in both directions, both whether the prenatal period is included in early childhood and how late early childhood extends. In this essay, the term early childhood is used to broadly refer to development from conception until the age of school entry. Specific analyses may use narrower time windows as noted.

roles of different factors in both total inequality and mediating socio-economic disparities. A number of potential mediators of socio-economic inequality are examined, including parental health knowledge, food quantity and quality, health conditions, the health environment, and prenatal development.

While numerous papers have examined the role of socio-economic status in child health inequality (e.g. Assaad, Krafft, Hassine, & Salehi-Isfahani, 2012; Khawaja, Dawns, Meyerson-Knox, & Yamout, 2008; Monteiro et al., 2010; Wagstaff & Watanabe, 2000), there has been little research on the factors that mediate these socio-economic disparities. Identifying the factors that mediate inequality in early health is crucial to understanding the causes of faltering and disparate early growth, as well as a necessary precursor to designing interventions to reduce inequality and ensure healthy growth.

Malnutrition, by definition, is the result of inadequate food quality and quantity. However, a large number of different factors, such as breastfeeding, complementary feeding, total calorie intake, and dietary diversity can contribute to nutrition. The disease environment, public health inputs (such as sanitation, water, and access to medical services), and parents' health practices and knowledge can contribute substantially to deficiencies in height and weight. Shortfalls in growth may also be shaped by children's development prior to birth, mediated through maternal health and nutrition and fetal growth. The roles of these different factors in malnutrition, and in mediating socio-economic inequality in child health, remain an unanswered question, and one with important policy implications for addressing malnutrition and the unequal distribution of child health both in Jordan and globally.

To understand the determinants of child health inequality in Jordan, this essay uses Jordan's 2012 Demographic and Health Survey (DHS). Jordan is a country with substantial socio-economic inequality in child health. While children from high socio-economic status backgrounds (for instance, from wealthier families) experience a healthy pattern of growth, children from poorer backgrounds experience poor and faltering early health. This clear differentiation in child health by socio-economic status makes Jordan an ideal case for studying the determinants of health disparities. Essentially, the differences between the rich and poor have the potential to fully illustrate the determinants that yield good or faltering early nutrition. The data available in the 2012 DHS for Jordan also provide a number of advantages in terms of rich information on socio-economic characteristics and detailed information about a wide variety of factors that could potentially mediate child health inequality. For example, the 2012 DHS includes information on food quantity and quality, with information on the feeding of a variety of different types of foods and the frequency of feeding. Information is also available on the mother's health knowledge, the health inputs and environment, health conditions, and prenatal development. The richness of these data allows for an assessment of the relative roles of different mediating factors in child health inequality, focusing on children under age two.

The findings of this essay demonstrate that a number of different factors contribute to inequality in child health. Some of the factors contributing to inequality in child health act as mediators for socio-economic disparities, and others have impacts that are independent of socio-economic status. The factors that tend to be the targets of malnutrition interventions, such as feeding practices and health knowledge (Horton, Shekar, McDonald, Mahal, & Brooks, 2010; World Bank, 2006, 2010), are not the most important mediators of socio-economic inequalities in child health in Jordan. Prenatal factors play the largest role in mediating socio-economic disparities in child health. Both birth weight (a measure of fetal growth) and maternal anthropometrics make large contributions to overall inequality and mediate socio-economic inequalities. These findings suggest that addressing inequality and deficits in child health will require sustained targeting of maternal health and nutrition before and during pregnancy. Policies and programs that target malnutrition during the early years may already be too late for many children in Jordan.

The essay proceeds as follows. Section 2 discusses the state of current knowledge on child health and nutrition. Section 3 provides a conceptual framework for child health and inequality. In section 4, the methods for measuring and decomposing inequality in height and weight are described. Section 5 describes the data, sample, and variables used in the analysis. Section 6 presents the results, first in terms of patterns of health and socio-economic status and then in terms of inequality of opportunity in child health and the factors that mediate this inequality. Section 7 concludes the essay with a discussion of the policy implications of these findings and suggests important directions for future research.

4.2 Literature on Child Health and Nutrition

4.2.1 Global Literature

Children's early health has long-lasting consequences. Early malnutrition has been linked to a number of negative later life outcomes across a wide variety of developmental domains. Victora et al. (2008) examine the links between undernutrition and human capital and find that height-for-age at age two is the best predictor of adult human capital, with links to health, education, and income. Glewwe and Miguel (2008) review what is known about the impact of child health and nutrition on educational outcomes and conclude that, although there are substantial challenges in estimating such relationships, the best evidence finds significant and sizeable impacts of child health on educational outcomes. Dercon and Sánchez (2013) show that, even after controlling for other factors, height-for-age early in life predicts psycho-social competencies in adolescents, including self-efficacy, self-esteem, and educational aspirations. These have been also linked to adult earnings. Stunting, as a measure of inadequate height-for-age, has been linked with lower levels of cognitive development, school achievement, adult economic and health outcomes, and health of subsequent generations (Dewey & Begum, 2011). Thus, identifying the causes of malnutrition is considered a crucial element of promoting human and economic development (Victora, Adair, Fall, et al., 2008).

Black et al. (2008) have a useful framework for understanding the causes and consequences of child undernutrition. They identify the basic causes of undernutrition as the social, economic, and political context, feeding into lack of capital (including financial, human, physical, social, and natural capital). These basic causes in turn generate the underlying factors affecting malnutrition, including income poverty, employment, type of dwelling, assets, and financial transfers. These underlying causes manifest themselves as: (1) household food insecurity, (2) inadequate care, and (3) an unhealthy household environment and lack of health services. These three underlying causes drive the immediate causes of malnutrition, namely disease and inadequate dietary intake, which can interact (Black, Allen, Bhutta, et al., 2008). Considering the many potential causes of undernutrition suggests a large number of potential pathways through which inequality in child health and especially socio-economic disparities could occur.

Malnutrition may also be directly passed across generations, as women who are malnourished are themselves more likely to have children with poor nutrition, especially low birth weights (Victora, Adair, Fall, et al., 2008). As a result of these different mechanisms, inequalities in child health due to disparities in economic status may also be an important part of the intergenerational transmission of socio-economic status (Case, Lubotsky, & Paxson, 2002; Currie & Moretti, 2007). Thus, understanding the roles of different factors in child health can play a key role in addressing not only contemporaneous inequality but also its intergenerational transmission.

The large number of different factors that can contribute to poor early health and nutrition is reflected in the diverse body of research on challenges to early health and interventions to promote and protect early development. Inadequate fetal development, measured in terms of intra-uterine growth restriction (IUGR), resulting in low birth weight (or being small-for-gestational age), has been identified as a key early factor in malnutrition, one that is often an outcome of maternal undernutrition or stunting (Bhutta, Ahmed, Black, et al., 2008; Black, Allen, Bhutta, et al., 2008; Black, Victora, Walker, et al., 2013; Dewey & Begum, 2011; Victora, Adair, Fall, et al., 2008). Programs targeting pregnant mothers with additional calories and micronutrients are therefore considered an important intervention (Bhutta, Ahmed, Black, et al., 2008).

Once children are born, feeding is a key target of interventions. There is a large body of literature showing that promoting exclusive breastfeeding, considered best practice for children under six months, can increase rates of breastfeeding. Although breastfeeding does have other health effects, such as reducing mortality, there is no clear evidence that breastfeeding will increase children's height and weight (Bhutta, Ahmed, Black, et al., 2008). Complementary feeding (the introduction of foods to infants) support and education programs are also considered crucial interventions to address feeding practices, and such programs have been demonstrated to increase children's height in both food secure and food insecure populations (Bhutta, Ahmed, Black, et al., 2008).

Conditional cash transfers that included maternal and infant health conditions have been shown to improve growth and reduce stunting. However, it is unclear if it is the health and nutrition conditions of the transfers or the increase in income that drives these effects (Gertler, 2004). Estimates of the income elasticity of energy intakes and specific nutrients suggest that increases in income would improve child health and nutrition (Bhargava, 2014). Specific micronutrients, such as zinc, can reduce malnutrition, and potentially intra-uterine growth restriction as well (Bhutta, Ahmed, Black, et al., 2008). Hygiene interventions, such as hand-washing, water quality, and sanitation, are also important for reducing diarrhea and thus improving nutrition outcomes (Bhutta, Ahmed, Black, et al., 2008; Spears, 2013).While the current literature does effectively document a wide variety of threats to nutrition and potential interventions across studies, it does a relatively poor job of addressing the issue of the relative roles of different factors in child health and nutrition, primarily focusing instead on single issues or assessing single interventions.

Although there are a complex variety of inter-related causes of malnutrition, the empirical literature on the determinants of health and nutrition that does examine multiple potential factors tends to focus on the most easily measured factors, including socio-economic factors such as parents' education and wealth, geographic location, access to clean water and sanitation, and gender (Assaad, Krafft, Hassine, & Salehi-Isfahani, 2012; Khawaja, Dawns, Meyerson-Knox, & Yamout, 2008; Monteiro, Benicio, Conde, et al., 2010; Wagstaff & Watanabe, 2000). The mechanisms through which socio-economic factors impact child health have received limited attention, despite their important implications for child health. One area that has received some attention in the literature is how mother's schooling affects child health (Behrman & Wolfe, 1987; Desai & Alva, 1998; Glewwe, 1999).

Other mechanisms have received scant attention in the literature. For example, although inadequate diet, in terms of quality and quantity, is a clear proximate cause of malnutrition (Bhargava, 2014), its role in inequalities in health and nutrition has not been adequately examined. Whether socio-economic inequalities are mediated through food quantity or food quality, or whether socio-economic and food effects are relatively distinct, has substantially different implications for the types of policies that are needed to address under-nutrition. For instance, it might be the case that feeding practices are sub-optimal regardless of socio-economic status, and thus feeding practices do not contribute to socio-economic inequality in malnutrition but do contribute to overall inequality. In contrast, access to water and sanitation may affect nutrition and vary substantially by socio-economic status. Targeting food aid to the poor would, in such a case, be a poor policy for addressing either overall malnutrition or decreasing inequalities, while targeted improvements in water and sanitation would be highly effective for both goals.

4.2.2 Early Health and Nutrition in Jordan

In the context of Jordan, the health and nutrition landscape shows a number of both supports and risks for children's growth. In terms of food access and diet, Jordan is considered to have undergone the "nutrition transition" from under-nutrition to a diet high in fat, sugar, and carbohydrates. Consumption of fruit and vegetables has decreased over time. Although nationally caloric intakes are high, poor households spend almost half of their income on food and do not have adequate intake (Madanat, Troutman, & Al-Madi, 2008). For instance, a study in Northern Jordan found that a third of women lived in households that were food insecure, with women reporting cutting down on food because of lack of money, not being able to afford balanced meals, and going hungry. Women who were less educated and in impoverished households were more likely to suffer from food insecurity (Bawadi, Tayyem, Dwairy, & Al-Akour, 2012). Almost half of women in poor urban households report their diet as inadequate, particularly in regards to consumption of meat and fish, dairy, fruit and vegetables, and carbohydrates (Mahasneh, 2001).

Jordan may have nutrition challenges, but healthcare utilization is high. The country has the highest rates of prenatal care and skilled delivery care (near 100%) among developing countries in MENA, as well as high rates of regular prenatal care (four or more visits, 95%) (El-Kogali & Krafft, 2015). Contraceptive knowledge is high (100% of married women in the DHS had heard of IUDs and the pill). Although current contraceptive use is also substantial (61% of married women are using contraception), there remains unmet need[78] for family planning among 12% of married women. In part due to their access to health care and family planning services, women in Jordan have relatively long birth intervals (a mean of 32 months), but there are disparities by wealth and education (Department of Statistics (Jordan) & ICF International, 2013). Although health care during pregnancy is relatively good, a study in Irbid (in Northern Jordan) identified deficits in pregnant women's nutrition behaviors. They did not achieve nutritional recommendations, particularly in regards to food quality and essential nutrients (Gharaibeh, Al-Ma'aitah, & Al Jada, 2005).

Once children are born, initiation of breastfeeding is prompt (Abuidhail, Al-Modallal, Yousif, & Almresi, 2014; Department of Statistics (Jordan) & ICF International, 2013). However, Jordan is far from the ideal six months of exclusive breastfeeding. In a study that followed mothers from post-partum in the hospital up to six months, while 68% of women said they would breastfeed when in the hospital, only 38% were exclusively breastfeeding after one month and just 1% until six months (the recommended period) (Abuidhail, Al-Modallal, Yousif, & Almresi, 2014). Part of the failure to exclusively breastfeed was a lack of knowledge; only half of women reported knowledge of exclusive breastfeeding. Further, this knowledge was linked to socio-economic status (income and education). Relatedly, incorrect beliefs about complementary feeding (the introduction of solid foods) and other post-partum practices

[78] Unmet need is defined as the percentage of fecund women who (i) are not using contraception and (ii) want to space the next birth or stop childbearing altogether (Department of Statistics (Jordan) & ICF International, 2013).

have been identified as common in Jordan (Jarrah & Bond, 2007; Obeidat, Salameh, Tayem, Mutair, & Gawasmeh, 2014). Discontinuation of breastfeeding and introduction of solid foods may be related to good intentions but inaccurate beliefs. Women often stopped breastfeeding because they thought the baby was still hungry after breastfeeding (Oweis, Tayem, & Froelicher, 2009) and gave complementary foods early in order to help children grow (Obeidat, Salameh, Tayem, Mutair, & Gawasmeh, 2014).

4.3 Conceptual Framework

4.3.1 Child Health Production

The literature on the causes of child malnutrition (Bhutta, Ahmed, Black, et al., 2008; Black, Allen, Bhutta, et al., 2008) and the general health production function literature (Cebu Study Team, 1992; Rosenzweig & Schultz, 1983; Strauss & Thomas, 1998), as well as previous work on child health inequality (Assaad, Krafft, Hassine, & Salehi-Isfahani, 2012), can serve as a starting point for understanding the determinants of children's height and weight. This essay posits the following general child health production function:

$$H = h(F, K, N, E, D, P; S, v) \tag{4.1}$$

where a vector of health outputs, H (i.e. height, weight), is produced by the function $h()$, based on a series of vectors of health inputs including food, F, mother's health knowledge, K, health conditions and practices, N, the health environment, E, maternal demographic and anthropometric characteristics, D, and prenatal development, P. The health inputs are selected in part by parents, and this selection may be affected by socio-economic characteristics, S, such as education, wealth, and income. Additionally, S may shape the technology of the production function. An element of random genetic variation, v, also affects height and weight.

The budget constraint households face is a particularly important part of the role of S in shaping inputs. In general, families can be assumed to be selecting health inputs for their children to maximize utility in the face of their budget constraints (Cebu Study Team, 1992; Rosenzweig & Schultz, 1983; Strauss & Thomas, 1998). However, some aspects of health inputs, for instance local sanitation or clean water (elements of E in equation (4.1)), may be linked to socio-economic status, for instance the government not providing sanitation or water in poorer neighborhoods, without being under the control of parents. Thus, some inputs cannot be actively selected by parents, but will be associated with socio-economic status. In assessing the empirical relationship between health and socio-economic status, both parents' choices based on socio-economic status and other relationships between socio-economic status and inputs will be estimated.

When estimating the determinants of health, the unmeasured term v, random genetic variation, will also pick up any unobservable determinants. If unobserved determinants are correlated with observed determinants, the estimated impact of observed determinants may be biased. For instance, in models of the determinants of child health where clean water is not accounted for, the direct role of food in the health production function will be over-stated if, for example, food insecure families live in areas with less access to clean water.

4.3.2 Inequality

Inequality is both deplorable and inevitable—not everyone can earn the same income, or be the same height. How, then, can economists or policy makers distinguish "problematic" inequality from "natural" inequality? Roemer (1998), drawing on various strands of political philosophy and economics, articulated a powerful and popular answer to this question with the concept of inequality of opportunity. He proposed that when considering inequality in outcomes, the portion due to "circumstances" beyond an individual's control should be distinguished from the portion due to "effort."[79] Inequality in outcomes due to differing levels of effort is morally acceptable, as effort is, by definition, under an individual's control, and also creates powerful incentives in the marketplace, as when individuals receive unequal wages in recognition of unequal effort. In contrast to effort, "circumstances" are factors that are outside an individual's control,

[79] The inequality of opportunity literature can also allow for factors within an individual's control to be influenced by circumstances. For instance, the "effort" exerted in school or work is likely to be affected by one's circumstances and can be considered as an indirect form of inequality of opportunity (Bourguignon, Ferreira, & Menendez, 2007).

such as gender, the location of birth, or parents' education. Inequality due to circumstances is considered to not be morally justifiable. This circumstance-related inequality is called inequality of opportunity.

There are some problems with Roemer's original conceptualization of inequality of opportunity when considering child health outcomes. First, when considering young children, no circumstances are under children's control. No differences in height or weight could be reasonably attributed to infants' inadequate "effort" to grow. To children, their parents' efforts and choice of health inputs are also circumstances outside of their control, with important impacts on their early health and nutrition. Thus, under Roemer's framework, all inequality in outcomes for this age group is, by definition, inequality of opportunity. This definition yields a very unrealistic standard of equality of opportunity requiring equal heights and weights for all children. This essay, as others have done (Assaad, Krafft, Hassine, & Salehi-Isfahani, 2012), modifies Roemer's concept to consider inequality of opportunity only that inequality due to *observable* circumstances. Since not all circumstances are observable, or observed in survey data, inequality of opportunity measured based on observable circumstances is therefore a lower bound on true inequality of opportunity. The remainder of inequality is considered to be "luck."

This partitioning of inequality based on what is observed in survey data has been identified as a serious shortfall, particularly when drawing policy implications. Yet even the critics of inequality of opportunity note that the underlying exercise in assessing inequality of opportunity, analyzing the determinants of various outcomes, is valuable (Kanbur & Wagstaff, 2014). Thus, this essay uses the inequality of opportunity approach as a method for summarizing the determinants of child health inequality, a method that quantifies the role of those determinants and their mediators, and additionally grounds them in an ethical framework.

4.4 Methods

4.4.1 Creating a Single Measure of Height and Weight

It is not possible to simply decompose inequality in height and weight directly. Height and weight progress with children's age, and inequality identified by directly examining height and weight will be confounded by relationships between height and weight, the age distribution, and covariates. One common method, which this essay uses, is to measure height and weight in terms of z-scores calculated by comparing observed height and weight to reference distributions of healthy children of the same age and sex. The resulting measures are referred to as height-for-age, weight-for-age, and weight-for-height. Height-for-age and stunting (2 SD below the median of the healthy reference population in terms of height-for-age) effectively capture long-term, chronic malnutrition. Weight-for-height and wasting (2 SD below the median of the healthy reference population in terms of weight-for-height) indicate rapid weight loss or acute temporary malnutrition (Black, Allen, Bhutta, et al., 2008). Height-for-age thus is, in part, an accumulated history of weight over time. Weight-for-age and underweight (2 SD below the median of the healthy reference population in terms of weight-for-age) include elements of both height-for-age and weight-for-height.

The WHO reference for z-scores is used, as it is the most recent growth standard (World Health Organization, 2006). Particularly for children, there does not appear to be ethnic variation in growth (Bustos, Amigo, Muñoz, & Martorell, 2001; Ulijaszek, 2001), so the WHO reference can be used globally. The healthy reference populations have a constant mean and variance in the z-score. Z-scores do not, however, have a particularly intuitive interpretation in terms of inequality and would alter the inequality indices. Z-scores also are problematic to use directly in inequality indices because they can be negative, and the best index for examining inequality in child health cannot handle negative numbers. Therefore, in this essay, z-scores are transformed back into height and weight measures in their natural units of centimeters and kilograms and standardized relative to the distribution of a single reference age and gender—in this case, a 24-month-old female child is used. This transformation, proposed by Pradhan, Sahn, and Younger (2003) allows for a more intuitive and less arbitrary scale in the inequality calculations and has been used in past studies (Assaad, Krafft, Hassine, & Salehi-Isfahani, 2012; Pradhan, Sahn, & Younger, 2003). Because the transformation, particularly for height-for-age, is essentially multiplying the z-score and adding a constant (World Health Organization, 2006), it will have little impact on either the regressions or the resulting inequality measures.

The standardized height, h_s, is calculated as:

$$h_s = F_{\bar{a},\bar{g}}^{-1}\left(F_{a,g}(h)\right) \tag{4.2}$$

where $F_{a,g}$ is a function that outputs height z-scores based on the distribution in the WHO healthy reference population for an individual age *a* and gender *g*. The observed height of that individual is h, $\bar{a}$ = 24 months, and $\bar{g}$ = female. Essentially, the z-score for a child of observed height *h*, age *a*, and gender *g* is calculated from $F_{a,\mathrm{g}}(h)$. The z-score is then used in the inverse function, $F_{\bar{a},\bar{g}}^{-1}()$ to calculate the height for a 24-month-old female with that z-score. An equivalent transformation is used for weight-for-age and weight-for-height.

4.4.2 Inequality Decompositions

Assessing the role of different factors in child health inequality and in mediating socio-economic inequality requires estimating both total inequality in child health outcomes (transformed height and weight) and the shares attributable to socio-economic factors before and after accounting for the potential mediators such as feeding or prenatal factors. The choice of inequality index, the path of decomposition (direct or residual) and whether parametric or non-parametric methods are used for decompositions will all affect resulting estimates of inequality and shares (Ferreira & Gignoux, 2008).

Assessing the shares of inequality attributable to different circumstances (distinguishing inequality of opportunity from the residual attributed to luck) requires a decomposable index. Generalized entropy (GE) indices are a class of inequality indices that are decomposable and have a number of other desirable theoretical and practical properties (Duclos & Araar, 2006). The GE(0) index (also known as the Theil-L index or the mean logarithmic deviation) measures the average deviation between the logarithm of the mean and the logarithms of observed values of a continuous variable as follows (Duclos & Araar, 2006):

$$\mathrm{GE}(0) = \int_0^1 \big(ln(\mu) - ln(Q(p))\big)dp \tag{4.3}$$

where μ is the mean value of the continuous variable of interest (transformed height, weight), p is the cumulative proportion of the population, where the population has been ordered from lowest to highest values of the variable of interest (e.g. shortest to tallest heights), and $Q(p)$ is the value of the continuous variable (height, weight) at cumulative proportion p. Essentially, the GE(0) index quantifies the differences between the observed distribution of values and their mean, in log terms. The GE(0) index emphasizes inequality at the lower end of the distribution, which is desirable in assessing child health, as extreme malnutrition is of particular concern.[80]

The GE(0) index can be decomposed into inequality of opportunity directly or indirectly (as a residual). A smoothed distribution can be used to eliminate all the residual inequality (leaving only inequality due to circumstances), or a standardized distribution can be used to eliminate all inequality due to circumstances (leaving only residual inequality due to luck). The smoothed distribution allows for an estimate of the share of inequality of opportunity in total inequality directly, while the standardized distribution calculates it as a residual (Ferreira & Gignoux, 2008). Only the GE(0) measure will generate the same results for both direct and residual methods (Duclos & Araar, 2006; Ferreira & Gignoux, 2008).[81]

This essay uses the standardized distribution, using the residual approach to calculating inequality of opportunity because, as discussed below, child health and

[80] The GE indices (and their transformations) are also the measures that satisfy standard axioms and decomposability for measuring inequality in a continuous outcome (Cowell, 2000). These axioms have been derived in a context of income inequality, but they appear to be transferable to the context of health inequality, particularly in the absence of an axiomatic approach for health or child nutrition.

[81] For indices other than GE(0), removing inequality due to circumstances or removing inequality due to luck will yield different estimates of inequality of opportunity because of additional terms in the decomposition. See, for instance, the decomposition of the coefficient of variation squared (Roemer, 2014) or other generalized entropy measures (Ferreira & Gignoux, 2011).

nutrition deteriorate with age. Age is also correlated with a number of other characteristics, such as feeding practices, and thus it is necessary to control for age. However, it would be undesirable to treat age as a circumstance, as all children will pass through different ages. Using the standardized distribution to estimate inequality of opportunity with age not being treated as a circumstance makes it possible to estimate inequality of opportunity without age confounding estimates.

While both parametric and nonparametric methods can be used to estimate how outcome y depends on circumstances, C, there are substantial tradeoffs associated with each of these two methods (Ferreira & Gignoux, 2008). Nonparametric methods allow one to partition the population into k groups, without any functional form assumptions on the relationships between circumstances and outcomes, simply comparing the group means and the population mean to estimate inequality. The main downside of this method is that, in order to retain adequate cell sizes for typical samples, very few circumstances rapidly exhaust the possibilities for decomposition. For instance, a relatively parsimonious specification, with three regions, three mother's education levels, two genders, and five wealth quintiles requires 90 groups to be estimated. With a minimum cell size of 100, this already requires 9,000 observations. It also does not allow for the use of continuous variables, unless they too are partitioned (for instance, partitioning food intake into more than four feedings or less than four feedings), which will substantially reduce the inequality attributable to these variables. Nonparametric methods were therefore not considered for this essay, since a large number of variables are of interest, as well as continuous and count variables such as birth weight and number of feedings.

Parametric methods require functional form assumptions (Ferreira & Gignoux, 2011). For instance, ordinary least squares (OLS) regressions, the method used in this essay, assume that circumstances are additive, although interactions can relax this assumption somewhat. The assumed additive functional form substantially reduces the data requirements and allows for the assessment of potentially many more circumstances contributing to inequality.

Recall that two relationships are of interest: both how socio-economic circumstances, *S*, generate child health disparities and how these disparities are mediated through a number of different factors, hereafter referred to as *M* (i.e. *F, K, N, E, D, P* in (4.1)). Thus, in line with studies that decompose inequality into the direct and indirect effect of circumstances (Bourguignon, Ferreira, & Menendez, 2007), this essay estimates both a "reduced form" model with just socio-economic status and a "structural" model that attempts to disentangle the effects of socio-economic mediators (as well as any additional effects they may have). Essentially, this approach assumes that *M* are a (linear) function of socio-economic status, *S*:

$$M_i = S_i\gamma + \eta_i \tag{4.4}$$

where γ is a vector of coefficients that link the socio-economic variables with the mediators.

The direct effects of socio-economic status (or residual effects of omitted variables, as socio-economic status should not act as a direct input) and the indirect effects through *M* on *y* (height and weight measures) can then be disentangled by estimating:

$$y_i = S_i\alpha + M_i\beta + \upsilon_i \tag{4.5}$$

This can be contrasted with the "reduced form" effects of socio-economic status:

$$y_i = S_i(\alpha + \beta\gamma) + \eta_i\beta + \upsilon_i \tag{4.6}$$

which are readily estimated as:

$$y_i = S_i\delta + \omega_i \tag{4.7}$$

Estimating first (4.7) and then (4.5) allows for a comparison of the magnitude of socio-economic effects and their mediators. Estimating (4.5) with subsets of *M*, such as those elements of the early environment only or prenatal environment only, can allow for identification of the relative role of different factors in mediating disparities by looking at the shifts in the contributions of *S* to inequality as various mediators are added. Since variables are actively omitted, different permutations are checked to ensure that omitted variables and the order of additions are not driving results.

To move from the estimation of regressions to inequality shares, let the equation

$$y_i = C_i\psi + \varepsilon_i \tag{4.8}$$

with the vector *C,* circumstances, be used as a generalization of (4.5) and (4.7). *C* includes *S* and can also include *M,* i.e. circumstances include socio-economic status and potentially mediators as well (depending on the specification). Then the estimated parameters, $\hat{\psi}$, are used to compute standardized distributions, $\tilde{y}_i$, as (Ferreira & Gignoux, 2011):

$$\tilde{y}_i = \bar{C}\hat{\psi} + \hat{\varepsilon}_i \tag{4.9}$$

where $\bar{C}$ is the vector of sample mean circumstances and $\hat{\varepsilon}_i$ is the estimated residual from equation (4.8). After differences in circumstances are controlled for by using mean circumstances, the remaining variability is exclusively in the residual, i.e. *within* types or circumstance groups. These $\tilde{y}_i$ can be used to calculate inequality of opportunity, θ_r, residually as a share of total inequality (Ferreira & Gignoux, 2008):

$$\theta_r = 1 - {\mathrm{GE}_0(\{\tilde{y}_i\})}\Big/{\mathrm{GE}_0(\{y_i\})} \tag{4.10}$$

The contribution of inequality of opportunity to overall inequality can thus be expressed as the share of total inequality due to circumstances.

The partial shares of a circumstance or group of circumstances *J* in inequality can be calculated based on a counterfactual standardized distribution (Ferreira & Gignoux, 2008):

$$\tilde{y}_i^{\,J} = \bar{C}^J\hat{\psi}^J + C_i^{j\neq J}\psi^{j\neq J} + \hat{u}_i \tag{4.11}$$

This is then used to estimate the share of circumstance set *J* in total inequality as:

$$\theta_r^J = 1 - {\mathrm{GE}_0\left(\{\tilde{y}_i^{\,J}\}\right)}\Big/{\mathrm{GE}_0(\{y_i\})} \tag{4.12}$$

These partial shares are the focus of this essay, especially how shares for socio-economic inequality are mediated through different determinants such as health knowledge or the health environment. Both inequality of opportunity and partial shares are tested for statistical significance by generating bootstrapped standard errors around the estimates.

4.4.3 The Problems of Omitted Variables and Measurement Error

Measurement error is a potential problem for both estimating inequality of opportunity and determining whether different factors mediate socio-economic inequality. A number of different variables could be mis-measured, starting with anthropometric measures. Although height and weight are the best-measured anthropometric measures (Ulijaszek & Kerr, 1999), major problems can still occur in fielding such measurements (Department of Statistics (Jordan) & Macro International Inc., 2008). Missing information on anthropometric indicators (data are missing for 7% of children) is relatively random (Department of Statistics (Jordan) & ICF International, 2013) and unlikely to induce bias. If there is random measurement error in the dependent variables (height, weight), the regressions of these outcomes on circumstances will not be biased (Bound, Brown, & Mathiowetz, 2001). However, the estimate of total inequality is likely to be biased upwards by random errors, thus increasing the denominator but not the numerator of inequality of opportunity and underestimating inequality of opportunity.

Because not all dimensions of socio-economic status are observed, estimates are likely to suffer from omitted variable bias. For instance, there are data on wealth based on an asset index, but not on incomes. Assuming that income and wealth have a substantial positive partial correlation, it is likely that the coefficient on wealth will be biased upward relative to the true effect of wealth. Omitted variable bias may affect various dimensions of socio-economic status differentially. If omitted income has a positive partial correlation with both wealth and education but a stronger partial correlation with wealth than education, both the wealth and education coefficients will be biased upward, but that of wealth more so. Since the primary use of the coefficients is generating the estimates of the contribution of socio-economic status to child health inequality, positive partial correlations between included and omitted socio-economic status variables will primarily increase the partial effect of socio-economic status towards its true value if all dimensions of socio-economic status were observed. Individual coefficients should be interpreted with some caution, keeping in mind potential omitted variables.

Measurements of socio-economic status that are available can be expected to have some degree of random error. In the regressions of anthropometric outcomes on circumstances, (randomly) mis-measured covariates will have coefficients that suffer from attenuation bias (Bound, Brown, & Mathiowetz, 2001). This will lead to an under-estimate of inequality of opportunity in child health related to socio-economic status. Overall, given at least some degree of measurement error and certainly missing dimensions of socio-economic status, the estimated inequality of opportunity in child health from socio-economic status is a lower bound.

When adding covariates that might mediate socio-economic inequality or have independent effects on child health inequality, an array of different measurement error problems might occur. Again, it is likely that many of the potential mediators will be measured with error, leading to attenuation bias in the regressions. This attenuation bias will in turn lead to an underestimate of inequality of opportunity. An additional set of considerations arises when comparing the partial effects for different sets of circumstances. Some dimensions of circumstances are likely to be better measured than others. Child gender, for instance, will probably be better measured than recall reports of whether breastfeeding initiation after birth was immediate, after one hour, after two hours, etc. This means that the estimated partial effects may be differentially attenuated depending on how extensive measurement error is.

The comprehensiveness of the observed variables in capturing a concept is also going to be a factor. Child gender can fairly readily be captured by a single variable, but health knowledge or differences in feeding practices are not so readily measured. Omitted variable bias may make interpreting findings problematic. For instance, geographic differences in child health outcomes are likely to be driven by omitted variables such as local access to health services or the local disease environment. Findings must be interpreted with caution, keeping in mind what is included or omitted as well as what is likely to be accurately measured.

A final problem arises in assessing the mediating roles of different factors in child health inequality. The assessment of factors' mediating roles will be affected by the extent of differential measurement in relation to links with socio-economic status. For instance, sewage connections may be closely related to housing characteristics and durable assets, which are captured by the wealth index, while the frequency of protein consumption relates more closely to current income, which is not measured directly but is proxied with assets and employment. Thus, if both sewage connections and protein feeding frequency actually equally mediate socio-economic disparities in child health, one would expect that sewage connections would appear to mediate more of socio-economic inequality of opportunity in this essay's necessarily partial and mis-measured estimates. Similarly, although the production function suggests that socio-economic status should have no direct effects on child health after all inputs have been accounted for, with mis-measured and limited information on inputs, it is likely that some partial effects from socio-economic inequality of opportunity will remain even after including all the available mediators.

All of these measurement problems of partial information, mis-measurement, and differentially captured mediation will be further exacerbated if any of the measurement error is systematic (related to covariates). For instance, survey teams may have rushed through interviews with poorer households that had poor heating and taken more care at richer households that were well heated. Or families from poorer households might be more sensitive about appearing to be poor, in terms of having limited food, and so they inflated the frequency of children's meals. These types of errors can introduce a large number of potential biases into the data.

In an ideal world, it would be possible to correct the measurement error problems. For instance, instrumental variables can be used to correct random measurement errors. However, instrumental variable solutions to measurement error cannot be used when there is measurement error in a binary or categorical variable (i.e. most of the variables analyzed in this essay). This is because measurement error in such variables is non-classical; there is always a correlation between the error and the true value (Bound, Brown, & Mathiowetz, 2001). Additionally, even for the continuous variables, a large number of valid instruments would be required to identify all of the potentially mis-measured variables. Such variables are not available in the DHS data, so no corrections for measurement error are undertaken. Thus, as in other studies (Bourguignon, Ferreira, & Menendez, 2007), measurement error will contribute to the residual or luck component of inequality. Overall, the different types of measurement error are likely to lead to under-estimates of inequality of opportunity, but to potentially differential extents for different variables. Thus, caution is required in interpreting the findings that follow.

4.5 Data

4.5.1 The Sample

This essay uses the 2012 DHS for Jordan. The survey sampled 15,190 households and 11,352 ever-married women ages 15-49 (Department of Statistics (Jordan) & ICF International, 2013). The survey is nationally representative. The data include anthropometric information (height and weight) for children under age 5, with a two-thirds random sample of households selected for anthropometric measurements. The 2012 DHS also includes questions that refer specifically to the youngest child under two years of age. For instance, food consumed by the child in the day preceding the survey, as well as the number of times during the day the child had consumed foods, is collected only for the youngest child under two. Thus, for the analyses of inequality of opportunity, the sample is further limited to these 2,230 young children. Any expansion in inequality occurring past this age or any catch-up in growth will not be captured by this analysis.

4.5.2 The Covariates

In order to identify the drivers of socio-economic disparities in children's nutrition, this essay first examines a number of socio-economic characteristics, such as parents' education and wealth, and their relationships with children's growth. In subsequent specifications, this essay incorporates a large number of measures of inputs to the child health production function, such as parents' health knowledge or feeding practices. These inputs are the mechanisms through which socio-economic disparities may be mediated. Comparing the estimates of inequality of opportunity with and without the input variables allows for an assessment of the mediating role of different inputs, such as feeding practices.

Table 4.1 describes in detail how individual variables are aggregated into categories. Two broad categories of socio-economic variables are considered, parents'[82] education and "wealth and employment." Parents' education incorporates mother's and father's education categorically. Wealth and employment incorporates the household wealth score (a factor variable),[83] parents' employment statuses, and employed parents' occupations. Education and wealth/employment may have different effects and different mediators in determining child health outcomes. For instance, parents' education may mediate health knowledge, while wealth and employment may mediate food quantity and quality.

In assessing the mediators of disparities, gender is considered (comparing females to males), to investigate whether gender discrimination is occurring generally or along socio-economic lines. Geographic differences are examined, in terms of governorates, rural versus urban, refugee camps versus non-refugee areas, and *badia* (arid areas) versus non-*badia*. Place of residence is not directly an input into the health production function. However, a number of potential mediators that cannot readily be measured in the data may be captured by place of residence, such as the local climate. Thus, if geographic differences mediate socio-economic disparities, this may be due to the disease environment, or differences in access to services such as sanitation, water, or health care. Geographic differences might also pick up ethnic disparities in health if certain ethnic populations are geographically concentrated.

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[82] The analysis excludes children whose mothers were not interviewed. Father's characteristics are available based on mother's report, regardless of whether the father was present in the household.

[83] Because the wealth score provided with the data is a standardized factor, including negative values, in order to incorporate the wealth factor and its square into regressions appropriately, the wealth factor had to be shifted into purely positive terms. This was done by adding the minimum value of the standardized variable to all wealth scores. Although the coefficients on wealth and its square will vary depending on the constant added, essentially a function with a constant, linear term, and quadratic term underlies any transformation that adds a constant (within the range of values that will yield only positive values of wealth) and thus the contribution of wealth and its square to inequality will be unchanged.

Feeding practices are a key area of investigation, as these are both a target of policy interventions and a frequently posited mediator for socio-economic disparities. Children from poorer families may consume less food or less diverse food. They may also have different chances of being breastfed. Information on breastfeeding initiation and whether a child is currently breastfed, exclusively breastfed, or fed with a bottle is incorporated into the category "food." In addition, the (categorical) frequency of feeding is incorporated. Being fed once, twice, thrice, or four or more times per day is the categorical breakdown. The frequency of feeding is a proxy for energy intake: depending on their breastfeeding status and age, children should be fed at least two or three meals a day, plus one or two snacks (Department of Statistics (Jordan) & ICF International, 2013; World Health Organization, 2005, 2008). The number of different types of foods, achieving a minimum daily variety of foods, and achieving certain minimums within certain types of foods, such as protein, all play an important role in adequate nutrition (Department of Statistics (Jordan) & ICF International, 2013; World Health Organization, 2005, 2008). Food types in the data are detailed to the level of "yogurt" or "carrots, red potatoes, or pumpkin." The essay aggregates information to assess the number of liquids, proteins, grains, and fruits/leafy vegetables fed as a part of the "food" category. Because feeding practices are closely related to age, age in months is controlled for, since, as discussed below, height- and weight-for-age decay over time, and could confound food/nutrition relationships. However, age is not considered a circumstance or mediator in the analyses.

Mother's health knowledge has been demonstrated in other contexts to be an important mediator of socio-economic disparities in child health (Glewwe, 1999). There are a large number of questions about mother's health knowledge in the DHS data. Variables for mother's knowledge of tuberculosis and oral rehydration salts (ORS) are incorporated into the analysis as measures of health knowledge that are likely to directly affect child health. A factor variable based on women's family planning knowledge is also included as a measure of general health knowledge.[84]

Health conditions, and how they are managed, may mediate socio-economic disparities in health and nutrition. Diarrhea and infection in particular have been linked to malnutrition (Glewwe, Koch, & Nguyen, 2004; World Bank, 2010). Although the entire history of episodes of illness is likely to drive current nutritional status, in the DHS data the only information on diarrhea is whether it has occurred in the past two weeks, along with its persistence (whether it is still ongoing). Likewise information on fever/cough in the past two weeks and its persistence is incorporated. These measures together constitute the category of health conditions.

A wide set of factors affect the health environment children experience. On the household level, the drinking water source, sewer connection, distance to health facilities, incidence of family smoking, and crowding (persons per room) may all mediate socio-economic disparities in nutrition by affecting the child's health environment. Since the DHS samples in clusters of approximately 20 households, the local (cluster) level health environment can be measured in terms of the drinking water source, sewer connections, and wealth of other households, all of which are likely to contribute to the health of children, particularly in terms of the potential disease environment in their community.

Two final factors that are considered are mother's demographics and child's birth weight (as recalled by the mother). Mother's demographics incorporate the height of the mother, her age (categorically) and birth spacing in months (or a dummy for being part of the first birth). Weight of the mother was considered but could be a product (rather than a cause) of the conditions that lead to child malnutrition. Mother's height (particularly her own stunting and malnutrition during childhood) has been shown to transmit across generations (Bhalotra & Rawlings, 2011). Mother's age at birth also has an important

[84] Additional data not included in the analyses measure health knowledge about HIV/AIDS, knowledge of sexually transmitted infections, knowledge of the fertile period, and other questions about knowledge of tuberculosis (Department of Statistics (Jordan) & ICF International, 2013). These questions were less relevant both to child health and as a measure of general health knowledge, since, for instance, there are fewer than 1000 reported cases of HIV in Jordan (Department of Statistics (Jordan) & ICF International, 2013). Interpretation of the additional questions was also potentially problematic, as disease and transmission knowledge could be indicative of illness rather than general health knowledge.

effect on health and nutrition outcomes (Kozuki, Lee, Silveira, et al., 2013). Teenaged mothers are particularly a hazard to child health but are also fairly rare in Jordan, with only 5% of 15-19 year-olds pregnant or having had a child (Department of Statistics (Jordan) & ICF International, 2013). Birth spacing, particularly short birth intervals, has been demonstrated to play an important role in maternal and infant health outcomes, and birth spacing has also been associated directly with child nutrition (Dewey & Cohen, 2007; Norton, 2005).

Birth weight, particularly low versus normal birth weight, has been shown in other contexts to drive long-term health and nutrition outcomes (Bhutta, Ahmed, Black, et al., 2008; Black, Allen, Bhutta, et al., 2008; Black, Victora, Walker, et al., 2013; Dewey & Begum, 2011; Victora, Adair, Fall, et al., 2008). Birth weight is likely to be a function of maternal nutrition and health preceding and during pregnancy, and socio-economic conditions will likely affect maternal and fetal health and nutrition. Birth weight may also pick up the effects of prematurity, as there is no gestation length/prematurity data in the DHS. Mother's demographics and birth weight together are considered to be mediators of the prenatal environment, while the health environment, health conditions, health knowledge, feeding, gender, and geographic differences will mediate primarily the early (post-natal) environment.

In order to quantify socio-economic disparities in child nutrition and to assess their mediators, the inequality decompositions are undertaken in sequence. This essay first estimates parametric regressions of the determinants of the standardized anthropometric measures and inequality of opportunity for socio-economic characteristics (education, wealth and employment) alone. Gender, geographic differences, food/feeding, health knowledge, health conditions, and the health environment are then added to the regressions to estimate how much of the socio-economic effects are mediated through these measures (how much the partial effects decrease after controlling for mediators). Lastly, mother's demographics and the child's birth weight are added to the analyses. This division of added regressors allows for the identification of socio-economic mediators after birth, and preceding birth, by comparing the latter two analyses.

4.6 Results

4.6.1 Patterns of Health and Nutrition

Overall, Jordan has a moderate problem with malnutrition. Figure 4.1 shows the distribution of height-for-age, weight-for-age, and weight-for-height z-scores for children under age five. Around 7.6% of children are stunted, and the average height-for-age is -0.39 SD. Around 3.0% of children under age five are underweight, and the average weight-for-age is -0.10 SD; weight falls just slightly short of a healthy reference distribution. Given the patterns for weight- and height-for-age, it is unsurprising that just 2.4% of children are wasted, and the average weight-for-height is 0.17 SD.

The rate of stunting is significantly higher than that expected in a healthy reference population (2.3% (World Health Organization, 2006)) at a statistical significance level below 0.01%. Average height-for-age and weight-for-age are below zero with significance levels below 0.1%. Wasting and underweight are not significantly different from 2.3%, but average weight-for-height is above zero with a significance level below 0.1%.

The pattern of nutrition by age shows different outcomes for average nutrition and acute malnutrition. Figure 4.2 shows the mean anthropometric outcomes by age in months with a locally weighted regression (lowess) curve to demonstrate trends. At birth and during the first year of life, average height-for-age, weight-for-age, and weight-for-height in standard deviations are similar to those for the reference population. Stunting, underweight, and wasting are relatively high at birth and decrease over the first 10 months of life. With some moderate fluctuations, height and weight measures fall starting at 10 months, with an especially steep decline through 20 months. Both stunting and being underweight increase from 10 months to 20 months of age before leveling off and slowly decreasing over time. In developmental terms, this suggests that on average children experience deteriorating nutrition throughout the early years but that acute malnutrition may be offset over time.[85]

4.6.2 Health and Socio-economic Status

There are large differences in health and nutrition by socio-economic status in Jordan. Although breaking the data down by both child's age in months and wealth quintile is somewhat noisy, Figure 4.3 shows that children from less wealthy households have poorer nutrition outcomes. Only children from the richest quintile remain near the healthy reference median (a z-score of zero) for height-for-age in Jordan. The poorest quintile has particularly low height-for-age and high stunting, with the worst period between 30-40 months before some recovery and partial convergence towards the other wealth groups. The patterns of height-for-age and weight-for-age presented by poorer children in Jordan are similar to those seen throughout low and middle income countries (Shrimpton, Victora, de Onis, et al., 2001; Victora, de Onis, Hallal, Blössner, & Shrimpton, 2010). Although differences in weight-for-age are smaller, there is also a clear socio-economic gradient in weight-for-age and being underweight. Weight-for-height, likely to measure transitory nutritional status, does not show such clear patterns.

Figure 4.4 examines whether these differences by wealth are significantly different across the age distribution, showing the smoothed values of height-for-age, weight-for-age, and weight-for-height for children from the richest and poorest quintiles. In addition, 95% confidence intervals are presented. Over almost all of the age distribution for height-for-age, the mean values for the children from the richest and poorest quintiles lie outside of each other's confidence intervals. For weight-for-age, the confidence intervals alternately do and do not overlap each other's mean values, particularly depending on which confidence interval one is looking at. Weight-for-height shows no clear pattern nor significant differences.

Focusing on the youngest child under two, the sample for the inequality of opportunity analysis, Table 4.2 shows anthropometric indicators, as well as the

[85] These differences by age in months are unlikely to be driven by cohort affects; the 2009 Jordanian DHS demonstrates similar patterns of nutrition by age in months.

distribution of the sample, by socio-economic status. There is a clear socio-economic gradient by parents' education, with children of secondary-educated parents showing a substantial improvement in health over preceding levels of education, and children of university-educated parents being particularly well-off. It is also only among the richest fifth of households that stunting, underweight, and wasting are all below the level observed in the healthy reference population. The poorest quintile is clearly the worst off; for instance, 16.7% of children from the poorest quintile are stunted compared to 0.7% of the richest children. Employment characteristics, which may be related to income, wealth, and education, also show clear socio-economic differences. Children with parents in white-collar occupations, such as professionals or managers, have better nutrition outcomes. Overall, there are clear disparities in child health by socio-economic status. However, the mediators of these factors are not immediately obvious, and are important information for designing interventions to address both inequality and lingering malnutrition in Jordan.

4.6.3 Inequality of Opportunity in Child Health

The first set of parametric regressions modeling the determinants of the standardized anthropometric measures yields estimated inequality of opportunity for socio-economic characteristics (education, wealth and employment) alone. This specification is referred to as "SES." In order to estimate the role of different factors in mediating socio-economic inequality, gender, geographic differences, food/feeding, health knowledge, health conditions, and the health environment are then added to the regressions. This specification's additions are referred to as "+ Early Environment." The final specification adds mother's demographics and the child's birth weight, which is referred to as "+ Prenatal Environment." Partitioning the added regressors in this fashion allows for the identification of socio-economic economic disparities, mediators after birth, and mediators preceding birth, by comparing the various analyses. Table 4.3 shows, for the analysis sample, the summary statistics for the different circumstances and covariates.

Table 4.4 (for height-for-age), Table 4.5 (for weight-for-age), and Table 4.6 (for weight-for-height) all show the underlying regressions for the outcomes transformed into the anthropometrics of a 24-month-old female, based on z-scores. Regressions are presented both without and with the addition of controls for age in months. Estimates of inequality of opportunity are based on the regressions where age is included as a control but does not contribute to estimated inequality of opportunity. Since age can contribute to total inequality but does not contribute to inequality of opportunity, the proportion of inequality due to circumstances is likely to underestimate inequality of opportunity in children's long-term outcomes.

Figure 4.5 presents inequality of opportunity under different specifications for the three anthropometric outcomes. Values underlying the figure, bootstrapped standard errors, and statistical significance are presented in Table 4.7. There is substantial (and, in the cases of height- and weight-for-age, statistically significant) socio-economic inequality of opportunity. In terms of height-for-age, 6.4% of total inequality is socio-economic inequality of opportunity. Approximately 4.3% of inequality in weight-for-age is socio-economic inequality of opportunity as is 2.1% of weight-for-height. These measures are for models including socio-economic circumstances alone. If all variables were perfectly measured these socio-economic circumstances would have no explanatory power once mediators were added.

Comparing subsequent specifications, it is notable how much additional inequality is explained with the added variables, suggesting that while the covariates may mediate socio-economic inequalities to some extent, they also have additional contributions to inequality that are unrelated to (measured) socio-economic status. Substantial measurement error in socio-economic status could also cause the addition of other variables to have an apparent direct role in inequality of opportunity when in fact the other variables are only mediating differences related to socio-economic status. Inequality of opportunity in height rises from 6.4% to 13.6% with the addition of early environmental factors, and further to 25.8% with the addition of the prenatal environment (mother's demographics and birth weight). The increase with the addition of the prenatal environment is particularly notable on two grounds. First, it is large, almost doubling inequality of opportunity, suggesting that more than half of explained nutrition inequality is determined prior to birth. Second, the resulting level of inequality of opportunity, 25.8%, is very large, particularly given that inequality related to age, which is substantial, contributes to total inequality and that much of natural genetic variation remains unaccounted for.

A similar pattern of increasing inequality of opportunity with the addition of variables across specifications is observed for weight-for-age and weight-for-height. Inequality of opportunity in weight-for-age rises from 4.3% with socio-economic status only to 12.9% with the addition of the early environment, and then to 22.9% with the addition of the prenatal environment. Again, there is both a large increase and a high level of inequality of opportunity after adding the prenatal environment. Weight-for-height rises from 2.1% to 7.3% and then to 10.1% as the early and prenatal environment are added. Notably, the addition of the prenatal environment explains only a little more, which is consistent with weight-for-height being driven by short-term fluctuations in nutrition and health.

Some of the inequality of opportunity detected here as relating to the prenatal environment may be related to genetic variation in anthropometrics and growth that occurs even among a healthy population. The importance of genetic variation in human development generally is vigorously debated in terms of nurture versus nature (Goldberger, 1979). There is a wide range of estimates of the proportion of differences due to genetic factors (heritability) for height and weight (Baker, Reynolds, & Phelps, 1992; Dubois, Kyvik, Girard, et al., 2012; Livshits, Peter, Vainder, & Hauspie, 2000; Towne, Guo, Roche, & Siervogel, 1993). Genetic factors affect not just birth weight or length but also the parameters of growth patterns (growth curves) after birth. A study using data from 23 twin birth-cohorts across four countries found that heritability was low at birth (4.8% to 8.7%) but increased with age. Thus, some of the estimated inequality of opportunity in terms of the prenatal environment may be related to genetic variation.

4.6.4 Mediators (Partial Effects) of Inequality in Child Health

A number of different factors mediate inequality of opportunity in child health. Figure 4.6 presents the partial effects for different categories of variables, in terms of shares of total inequality under different specifications for the different anthropometric outcomes. Values underlying the figure are in Table 4.7. Looking at socio-economic status alone, there are effects for both parents' education and wealth and employment, particularly for height- and weight-for-age. Around 4.6% of height-for-age inequality is due to wealth and employment, and 3.0% is due to parents' education.[86] Weight-for-age likewise shows a larger effect from wealth and employment than from education, but the opposite is true for weight-for-height.

Adding the child's early environment reduces the impact of parents' education but has little or no effect on the wealth/employment effects for weight-for-age or height-for-age; it reduces wealth/employment effects more than education effects for weight-for-height. Little of the long-term patterns of inequality in nutrition by wealth or employment are mediated through the early environment; it is not feeding, health knowledge, health conditions, or the health environment that contribute to wealth/employment inequality, but these do have some effect on education related socio-economic inequalities. That these factors are mediating little wealth/employment effect and only a modest education effect is particularly interesting given that, in a number of dimensions of these health inputs, there is clear socio-economic inequality. For instance, although there are not large socio-economic differences in breast-feeding, there are socio-economic disparities for mother's education and especially wealth in terms of complementary feeding (Department of Statistics (Jordan) & ICF International, 2013). Yet these differences do not seem to be driving the socio-economic disparities in child health observed in Jordan.

However, when adding the prenatal environment, there is a larger drop in wealth/employment inequality of opportunity and a small drop in education-related inequality (for height- and weight-for-age). The pattern of prenatal factors mediating wealth and employment differences but not education differences was confirmed by

[86] Partial effects do not necessarily add exactly to total inequality of opportunity.

adding the prenatal factors alone (excluding the early environment) to the SES variables and seeing a large decrement in wealth and employment but not in education.

Thus, wealth and employment disparities are mediated primarily by prenatal development. Notably, there remain substantial disparities by socio-economic status even after the many variables included have been added.[87] For example, even after adding the early environment and prenatal factors, 1.9% of inequality in height-for-age is attributable to parents' education and 2.0% is due to wealth and employment. Insufficiently precise measurements of other covariates, such as health knowledge, may contribute to these lingering effects, but they also suggest that there are other socio-economic effects not yet measured or accounted for that may contribute to socio-economic disparities. Issues such as the disease environment (poorer families living in areas with higher burdens of parasites, for instance) may drive these remaining effects.

A number of different individual partial effects mediate socio-economic status or make additional substantial contributions to inequality in children's nutrition. There is essentially no gender inequality and only small and insignificant geographic inequality. Food and feeding practices do contribute substantially to inequality, particularly to weight. Around 3-4% of inequality in weight-for-age is related to feeding, and this is sometimes statistically significant across specifications. The smaller contributions of food and feeding to height may be because concurrent feeding affects weight, and the full history of feeding affects height, so effects on height are underestimated. Health knowledge has at most a small and never statistically significant contribution. Because parents' health knowledge may manifest itself in terms of feeding practices or health conditions, the importance of health knowledge is particularly likely to be under-estimated. However, if, for instance, knowledge of oral rehydration salts (ORS) played a central role in health inequality, that should still be picked up in terms of an impact of health knowledge rather than other covariates. Health conditions likewise have small and

[87] Differences by socio-economic status are unlikely to be driven by particular components of the asset index, such as refrigerators, freezers, or dishwashers, which might affect food safety, as there is little variation in household ownership of these three assets. Almost all families have refrigerators, fewer than 10% have freezers, and almost none have dishwashers.

insignificant effects, although health conditions are only measured for the past two weeks and not a full history.

The early health environment, on both the household and local level, does have a large and statistically significant contribution to inequality of opportunity for height-for-age, contributing around 5% of total inequality. In the regressions (Table 4.4), cluster level wealth, sanitation, and water all have large effects and appear to matter more than the corresponding household level characteristics, suggesting that the health/disease environment contributes to inequality in height primarily on a community rather than a household level.

The contributions of maternal demographics (age, height, and birth interval) are large and significant for height-for-age, where they contribute 7.4% of total inequality. Effects are smaller (2% or 1%) and insignificant for the weight measures. The effects of maternal demographics, driven primarily by mother's height (Table 4.4), are a clear intergenerational transmission of long-term nutritional outcomes. Each additional centimeter in mother's height predicts an additional 0.136 centimeters of height for a 24-month old female, after accounting for other characteristics and age in months. Transmission of genetic factors across generations may play an important role in the effects of maternal demographics, but given estimates of heritability (Dubois, Kyvik, Girard, et al., 2012), which should also manifest in measures like birth weight, genetic factors can be expected to be only part of the relationship across generations. Both nature (genetic factors) and nurture have been identified as key factors in the intergenerational transmission of health, economic, and education outcomes (Behrman & Rosenzweig, 2004; Bjorklund, Lindahl, & Plug, 2006). Other mechanisms may be occurring. For instance, maternal undernutrition has been linked to low birth weight (Victora, Adair, Fall, et al., 2008), and maternal height has been linked to stunting and underweight in global studies (Ozaltin, Hill, & Subramanian, 2010).

Much of children's nutrition is also driven by health and nutrition accumulated prior to birth; 11.2% of inequality in height-for-age and 12.0% of inequality in weight-for-age is determined by weight at birth (both are statistically significant). Each additional kilogram of birth weight predicts an additional 1.848 centimeters of height for a 24-month old female, after accounting for other characteristics. In Jordan, 13.8% of births have low birth weight (weigh less than 2.5 kilograms) (Department of Statistics (Jordan) & ICF International, 2013). Although comparability of national statistics may be problematic, this is a relatively high share of low-birth-weight infants, particularly considering Jordan's performance on other anthropometric measures. The shares for the United States and United Kingdom are 8% and the average for the least developed countries is 13% (UNICEF, 2014). Weight-for-height, capturing short-term fluctuations, has only a 1.6% contribution from initial status, consistent with prenatal growth affecting long-term patterns but not short-term fluctuations.

4.6.5 Further Explorations of Mediators of Inequality in Child Health

The role of prenatal factors in overall inequality of opportunity in child health and particularly in mediating socio-economic opportunity is notable. Figure 4.7 and Figure 4.8 further explore the relationship of socio-economic status, specifically wealth, with birth weight and mother's height. Looking first at birth weight (Figure 4.7), there are clear differences in the pattern of birth weights by wealth quintile, with children in the poorest quintile in particular having a disproportionate chance of being low-birth-weight (below 2.5 kilogram) infants, 16%. The poorest generally have slightly lower birth weights overall, averaging 3.0 kilograms, compared to 3.2 kilograms for the richest. There is a clear gradient (not shown) through the richest quintile, with children from the richest quintile particularly disproportionately represented among relatively heavier birth weights.

There is a similar pattern for mother's height by wealth quintile (Figure 4.8), with a particularly strong gradient by wealth in the share of children whose mothers have short stature. Short stature here is defined as a height less than 151.1 centimeters, the 3rd percentile of the CDC reference for a healthy 20-year-old female (Centers for Disease Control, 2001). The entire distribution for the poorest quintile appears shifted to lower heights relative to the other wealth quintiles (only richest shown), while mothers from the richest wealth quintile are disproportionately likely to have heights near 170 centimeters, in the taller end of the distribution. These prenatal disparities in fetal growth and maternal height have clear gradients by wealth, especially at the lower ends of the distributions where they are particularly likely to have adverse consequences for children's growth and health. Although genetic factors inherited across generations could contribute to some extent to the impact of prenatal factors on inequality of opportunity in child health, prenatal factors are also closely linked with socio-economic status. One study of twins (Behrman & Rosenzweig, 2004) suggests that the impact of birth weight, as a prenatal factor, on adult outcomes would actually be underestimated in cross-sectional estimates such as these that do not account for genetic endowments. The disproportionate share of low birth weights and short mothers in the lowest wealth quintile in particular suggests important links between socio-economic status, the prenatal environment, and child growth—links that will in turn impact adult outcomes.

While prenatal factors were identified as playing a larger role in child health inequality and socio-economic disparities, it may be the case that prenatal factors are better measured than early environmental factors, and thus measurement quality is driving the results. One factor that has been identified as a particularly important mediator of child malnutrition is diarrhea; the prevalence of diarrhea tends to rise at the same point in time as the precipitous decline in children's nutrition (Glewwe, Koch, & Nguyen, 2004). Figure 4.9 explores the relationship between diarrhea, its persistence, socio-economic status, and children's age. The percentages of children who had diarrhea within the past two weeks (but do no longer) and children who had persistent diarrhea are graphed against children's age for the children from the poorest and richest quintiles. Recall from Figure 4.2 and Figure 4.3 that the major decline in child nutrition occurs from approximately 10 months to 20 months. As Figure 4.9 shows, diarrhea is relatively low in the few months after birth and then rises, with the peak prevalence occurring in the 10-20 month range. The rise in diarrhea coincides with the period when children are increasingly interacting with foods and becoming increasingly mobile, exposing them to substantially more germs.

However, the comparison of the poorest and richest children's experience of diarrhea is not consistent with the faltering of poor (but not rich) children's growth being due to diarrhea; very similar patterns of diarrhea occur from 0-20 months for the poorest and richest children. While the poorest children initially have slightly higher rates of persistent diarrhea, rates converge by the time when the poorest children start to falter in their growth. Differences in diarrhea prevalence by wealth occur primarily from 20 months onwards, which is when growth faltering stops, mean height-for-age stabilizes, and some recovery begins. Additional analysis also demonstrated that treatment of diarrhea (oral rehydration salts, antibiotics, etc.) was similar across wealth quintiles. Although these analyses are not the same as being able to include the full history of diarrhea and other health episodes in the calculations of child health inequality, they do indicate that diarrhea is unlikely to be the driving cause of the precipitous decline in child health for poorer children, while richer children continue to develop relatively normally.

4.6.6 Simulating Policy Priorities

The sizeable inequality of opportunity attributable to prenatal factors translates into large differences in children's anthropometric outcomes. As a further demonstration of the relatively large role of prenatal factors in child health and child health inequality, Figure 4.10 shows how different circumstances can lead to substantially different child health outcomes for selected covariates from the regressions: birth weight, mother's height, the frequency of daily protein feedings, diarrhea and its persistence, and cluster level sewage connections. These are some of the circumstances that have the greatest impact in the regressions. The figure demonstrates what would happen to average height-for-age z-scores if each circumstance were moved from the 5th to 95th percentile of its distribution (with all other circumstances as observed) as a demonstration of the importance of these different factors. This shift in birth weights represents a movement from average z-scores of -0.87 to 0.28. A shift from the 5th to 95th percentile in mother's height moves z-scores from -0.62 to 0.18. Increasing the frequency of daily protein feedings from the 5th to 95th percentile of the distribution raises average z-scores from

-0.41 to 0.01. Going from persistent diarrhea to none increases z-scores from -0.56 to -0.22. Raising the cluster-level sewage from none to universal raises z-scores from -0.46 to 0.00.

If these different simulations are considered as policy interventions, targeting birth weights has by far the highest impact, increasing z-scores 1.15, equivalent to 3.7 centimeters for a 24-month female. Shifting the distribution of mother's heights leads to a 0.79 change in z-scores, equivalent to 2.6 centimeters for a 24-month female. Although actually changing mother's heights is a very long-term change, targeting mothers with short stature for nutrition support could have similar effects. All the rest of the potential policy levers—increasing the frequency of protein feedings, eliminating diarrhea, and moving to universal sewage—have much smaller policy impacts, less than 0.50 differences in z-scores, or between 1.1 and 1.5 centimeters of height. While still valuable, the impact of such investments pales in comparison to interventions targeting the prenatal period.

Although prenatal factors have the greatest impact on child nutrition outcomes, they are not necessarily the best policy alternative. Determining priority policies for child health and nutrition would require an assessment of the relative costs and benefits of different approaches. The existing evidence indicates that the benefits of reducing low birth weight are substantial, but only some interventions, such as targeting women with poor obstetric histories, have sufficient information to assess benefit-cost ratios. A few interventions are clearly promising; for instance, providing medicine to women with poor obstetric histories has benefit-cost ratios in the range of 4-35 dollars of benefits for each dollar of cost (Behrman, Alderman, & Hoddinott, 2004). Other studies, although lacking the necessary information to assess benefit-cost ratios, demonstrate that food supplementation during pregnancy can increase children's birth weights, particularly when mothers are malnourished (Fall, Yajnik, Rao, et al., 2003; Imdad & Bhutta, 2012; Mardones, Urrutia, Villarroel, et al., 2008; Shaheen, de Francisco, El Arifeen, Ekström, & Persson, 2006; Yang & Huffman, 2011). There are differences in supplementation impacts based on the nature of the supplement, such as what nutrients and micronutrients are included, as well as the duration of exposure to supplements.

Additional studies assessing the relative costs and benefits of alternative interventions to reduce low birth weight, such as protein/energy supplementation for pregnant women, would be extremely valuable. Programs to improve birth weight have been identified as an area with limited evidence, particularly in comparison to growth promotion and micronutrient programs (Horton, Shekar, McDonald, Mahal, & Brooks, 2010; World Bank, 2006). Additional analyses of the predictors of birth weight in the Jordanian 2012 DHS suggest that some of the policy levers for child health and nutrition may also be effective for fetal and maternal nutrition. For instance, community-level sewage access was predictive of birth weight (results not shown), a pattern that may be due to a relationship between local sanitation, mother's health and weight-gain during pregnancy, and fetal growth.

4.7 Discussion and Conclusions

Children's early development has important implications for their long-term wellbeing. Faltering growth during the early years—or indeed, even before birth—leads to worse health, education, and labor market outcomes by adulthood. Early childhood is also the starting point for inequalities in children's development, determined by circumstances entirely outside of their control. This essay demonstrated that there are substantial socio-economic disparities in child health in Jordan, particularly in terms of height, which is the best measure of accumulated nutrition (or lack of nutrition) and is crucially related to a number of different dimensions of human development.

A number of different possible determinants for inequality of opportunity in child health were examined, which might mediate socio-economic disparities as well as make additional contributions to inequality. While food and feeding contributed substantially to inequality in weight, they appeared to mediate little of the observed socio-economic disparities. The effects of parental education were only slightly reduced and the effects of wealth and employment relatively unchanged with the addition of early environmental measures. Health knowledge, geographic differences, and gender had small contributions at most. The health environment, particularly local water, sanitation, and wealth, did contribute substantially to inequality of opportunity but did not appear to mediate socio-economic disparities, instead largely making additional contributions to inequality.

Notably, almost half of the maximum explained inequality in weight-for-age and height-for-age was driven by outcomes that were determined prenatally. Birth weight in particular, which is likely to be a measure of poor maternal health and nutrition leading to intra-uterine growth restriction, played a large role in inequality. Other studies have likewise found that a large share (20%) of stunting is attributable to insufficient fetal growth (Christian, Lee, Angel, et al., 2013). In utero rainfall (and therefore nutrition) shocks have been shown to have a larger effect on long-term growth than shocks in the first two years of life (Leight, Glewwe, & Park, 2015). Maternal demographics (especially height) also played a large role in unequal height-for-age and represent intergenerational transmission of health inequalities.

Some of the estimated inequality due to prenatal measures may also be related to natural genetic variation, but estimates of heritability (Baker, Reynolds, & Phelps, 1992; Dubois, Kyvik, Girard, et al., 2012; Livshits, Peter, Vainder, & Hauspie, 2000; Towne, Guo, Roche, & Siervogel, 1993), which measure the share of variation in health outcomes due to genetic factors, indicate that natural genetic variation is likely to be only a small part of these prenatal effects. Studies have also directly linked prenatal nutrition (birth weight) with adult health outcomes, as well as schooling and labor market outcomes, even after controlling for genetic endowments (Behrman & Rosenzweig, 2004). The disproportionate importance of the prenatal environment to later life outcomes such as education, income, and health has also been emphasized in the "fetal origins" literature (Almond & Currie, 2011a; Lin & Liu, 2014). Prenatal development tends to be more important than post-natal development for the formation of human capital, although both periods make important contributions (Almond & Currie, 2011b).

These findings, particularly the substantial socio-economic disparities and the large disparities that are determined prenatally, have important implications for nutrition policy and policies addressing health and nutrition inequalities. The large role of prenatal factors suggests that an important emphasis in health and nutrition interventions should be intervening before and during pregnancy (Black, Victora, Walker, et al., 2013). However, much of the current landscape of research, policy, and interventions places the greatest emphasis on the early environment and issues such as breastfeeding, complementary feeding, or health knowledge and behaviors (Bhutta, Ahmed, Black, et al., 2008; Black, Victora, Walker, et al., 2013; Horton, Shekar, McDonald, Mahal, & Brooks, 2010; World Bank, 2006, 2010)—issues that, while important, are relatively secondary, at least in Jordan. These findings suggest that countering malnutrition after children are born may already be too late in Jordan. Although this study looked at only one country, research in other contexts suggests that other countries may have similar deficits in prenatal growth that drive early malnutrition. For instance, in an indigenous population in Guatemala that had an approximately 50% rate of stunting at 0-6 months, the strongest predictor of early infant growth failure was impaired fetal growth (Berngard, Berngard, Krebs, et al., 2013).

Given the near-universal use of prenatal care and the relatively high frequency of such care in Jordan (Department of Statistics (Jordan) & ICF International, 2013), an important entry point for potential interventions in Jordan will be addressing maternal nutrition and fetal growth within prenatal care. Follow-up care related to birth weight (determined at delivery) could also be crucial to redressing disparate health outcomes that are related to poor fetal growth and low birth weight. Targeting additional support for the health and nutrition of children with poor nutrition status at birth will be an important part of improving nutrition—and reducing socio-economic disparities. Globally, public health spending plays a particularly important role in the health of the poor (Bidani & Ravallion, 1997), so public health interventions for prenatal nutrition and development may be particularly important.

The findings of this essay indicate a number of important directions for future research. The far more detailed specification of inequality of opportunity in this essay as compared to previous work (Assaad, Krafft, Hassine, & Salehi-Isfahani, 2012; El-Kogali

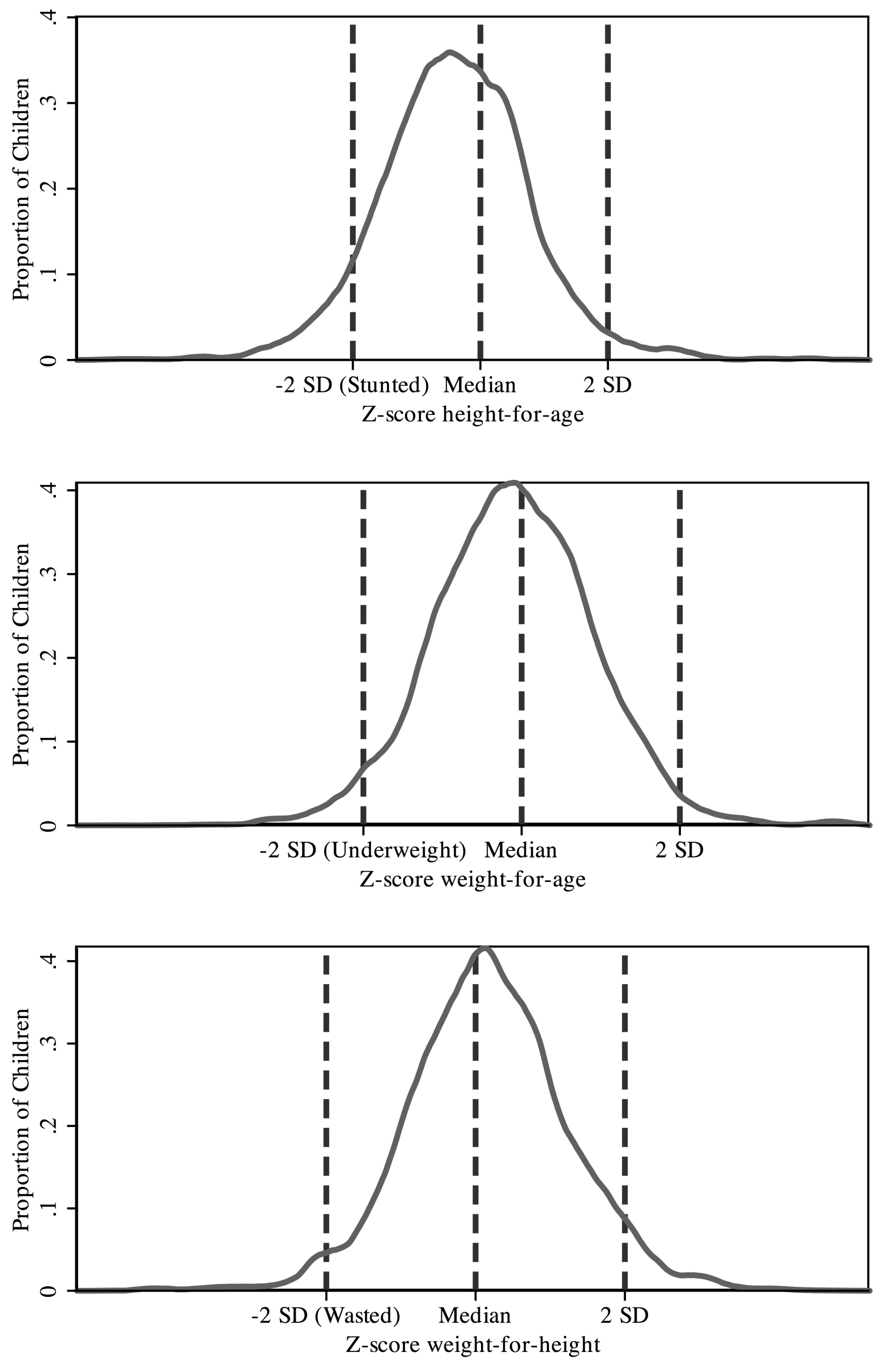
& Krafft, 2015; Krafft & El-Kogali, 2014) has led to a far higher estimate of inequality of opportunity in child health than previous work had indicated for Jordan or other countries in the region. This essay's relatively high estimate of inequality suggests that there are typically a large number of important factors omitted (or, more often, not available in the data) in assessing child health inequality. The contributions of factors such as birth weight and feeding need to be considered in other contexts.

Although the 2012 DHS for Jordan had relatively rich data, the factors included in this essay were measured imperfectly. For instance, data were available about feeding frequency, but this is only a rough proxy for caloric or energy intake, so the effects estimated here are likely a lower bound on true inequality of opportunity. Measurement problems may also differentially affect the estimated partial effects, depending on how well measured different factors are (see earlier discussion on measurement error). In Jordan as well as in other contexts, there is a clear need for much richer data to assess the determinants of children's health and nutrition and the drivers of inequality in these critical outcomes. An important contribution of this essay is its discussion of the complexities of identifying disparities and their mediators in the context of measurement error and omitted variables, a neglected issue in studies of health inequality.

Further research is needed in other countries to assess whether the pattern of predominant prenatal factors, which also has been found to occur in other contexts (Berngard, Berngard, Krebs, et al., 2013; Neumann & Harrison, 1994), is widespread. There is also insufficient research on the impact of nutrition interventions during pregnancy, but existing evidence shows such interventions can be effective, especially when mothers have poor nutritional status (Imdad & Bhutta, 2012; Merialdi, Carroli, Villar, et al., 2003; Rasmussen & Habicht, 2010). Particularly if this pattern is common globally, future research needs to investigate interventions targeting not only early childhood nutrition after children are born but also maternal and fetal nutrition and health to assess how best to prevent or remediate these key drivers of child malnutrition.

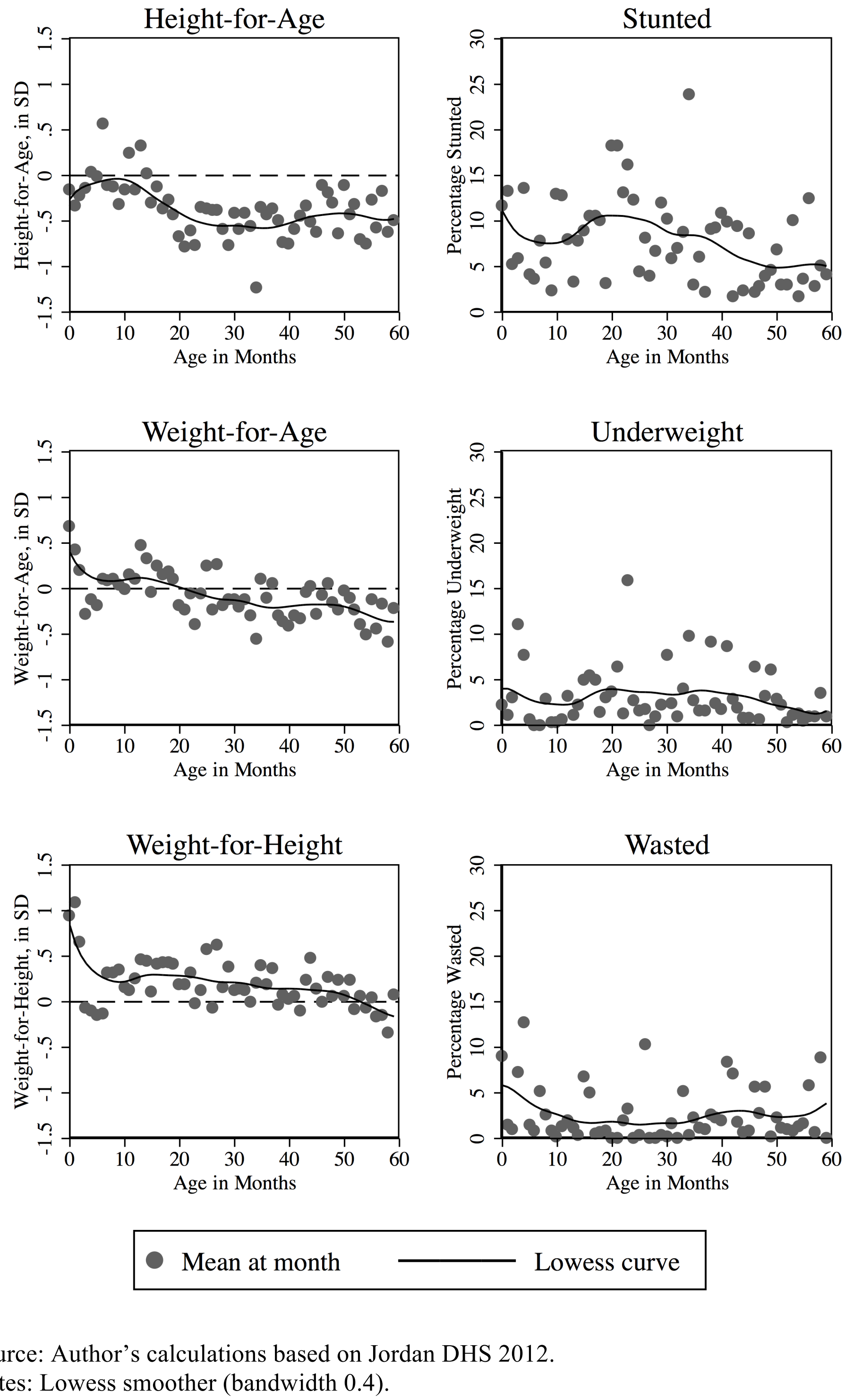
Figures

Figure 4.1. Distribution of Anthropometrics



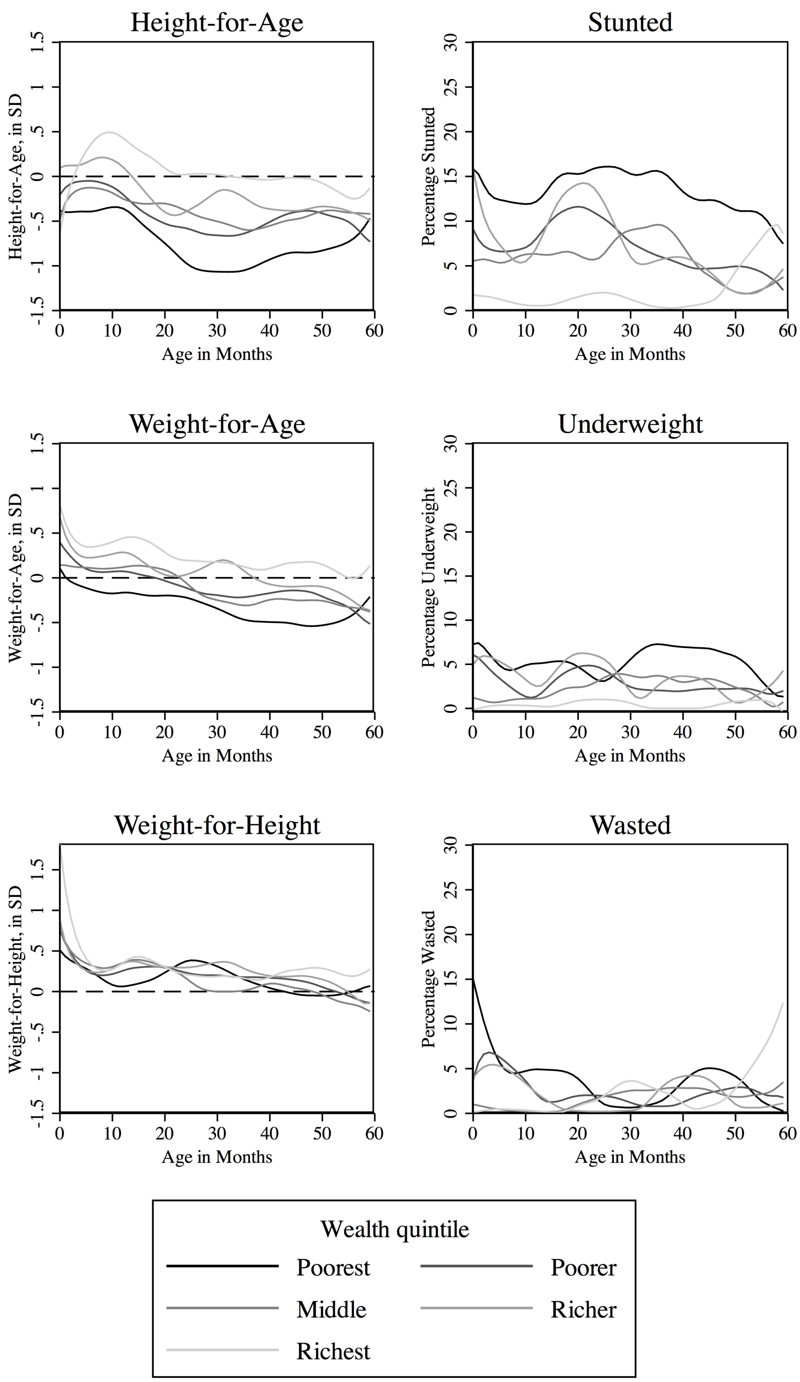
Source: Author's calculations based on Jordan DHS 2012.
Notes: Kernel densities, using Epanechnikov kernel (bandwidth 0.4).

Figure 4.2. Anthropometrics by Age in Months



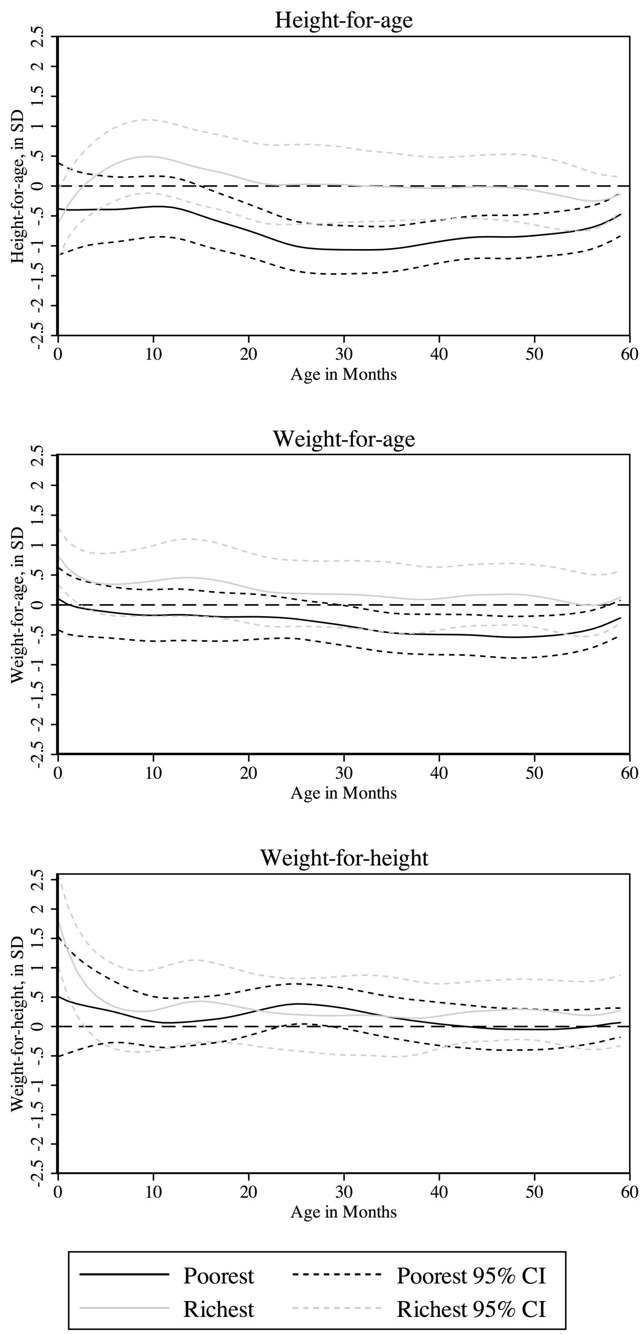
Source: Author's calculations based on Jordan DHS 2012.
Notes: Lowess smoother (bandwidth 0.4).

Figure 4.3. Anthropometrics by Age in Months and Wealth Quintile



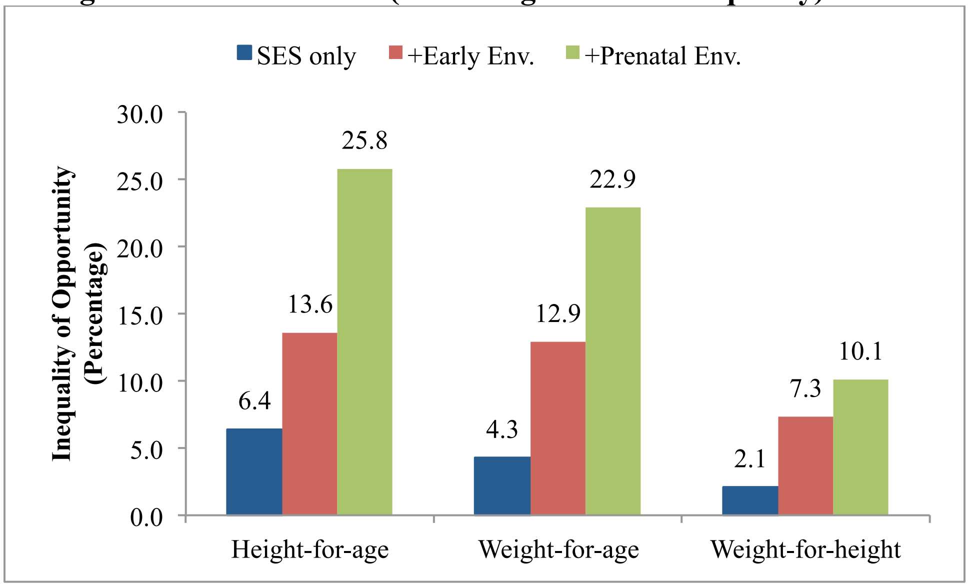
Source: Author's calculations based on Jordan DHS 2012.
Notes: Lowess smoother (bandwidth 0.4).

Figure 4.4. Anthropometrics by Age in Months, Poorest and Richest Quintiles and Confidence Intervals



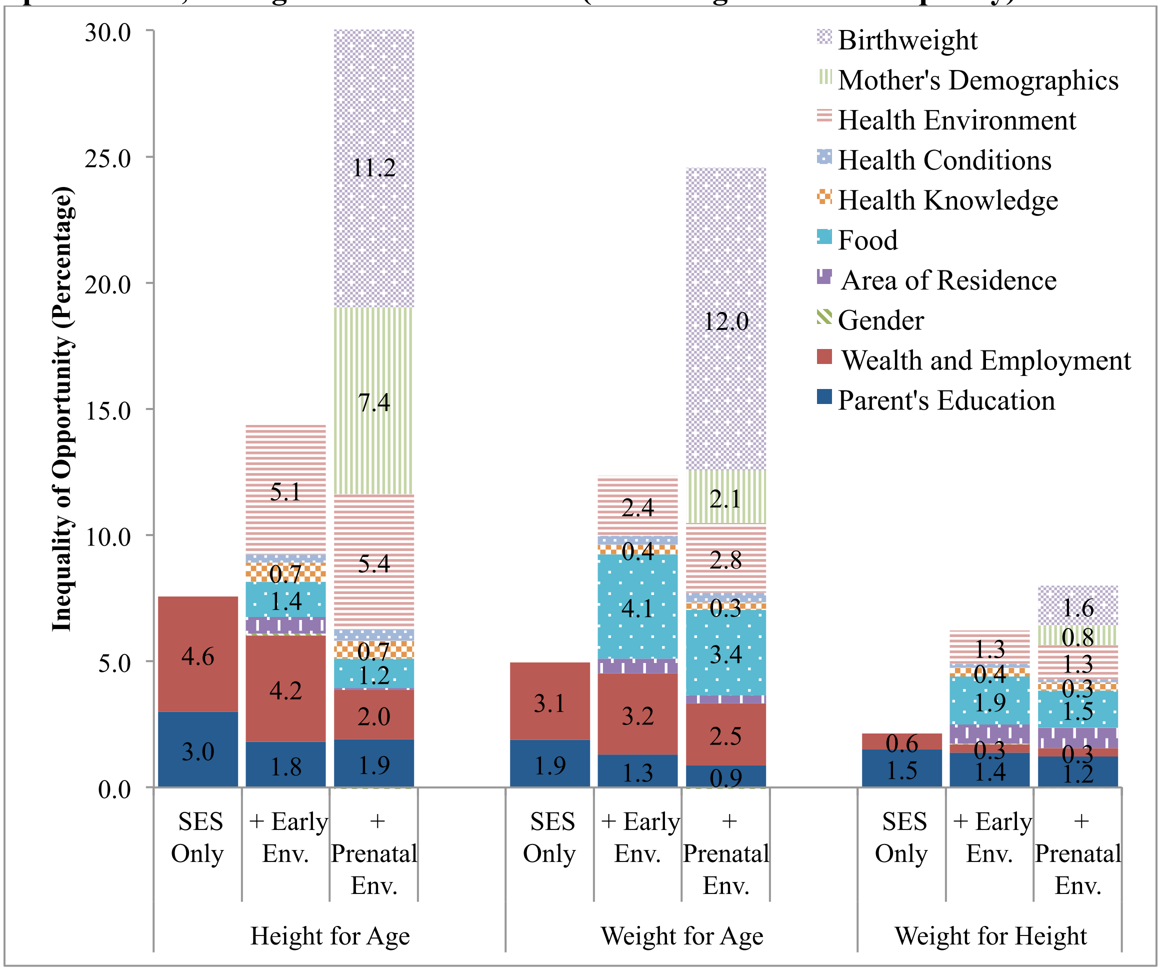
Source: Author's calculations based on Jordan DHS 2012.
Notes: Lowess smoother (bandwidth 0.4). The 95% confidence intervals are constructed using the standard errors for the means at each month.

Figure 4.5. **Inequality of Opportunity in Anthropometrics by Specification, Youngest Child Under Two (Percentage of Total Inequality)**



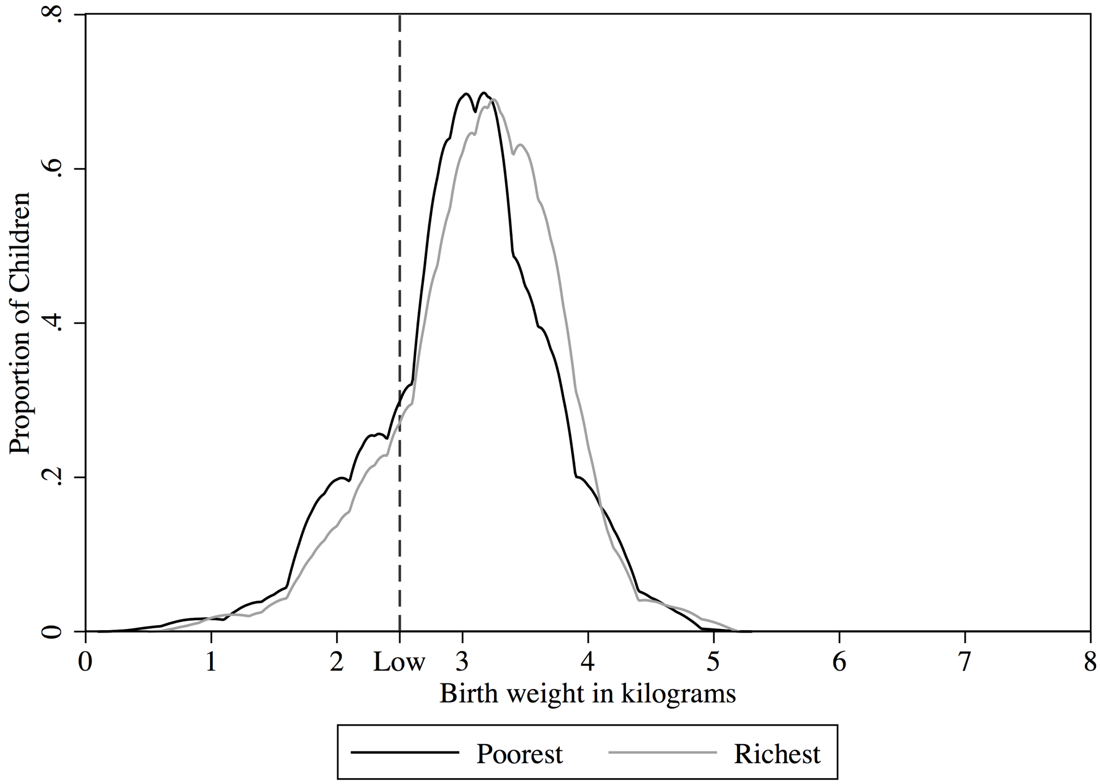
Source: Author's calculations based on Jordan DHS 2012.

Figure 4.6. **Partial Effects, Inequality of Opportunity in Anthropometrics by Specification, Youngest Child Under Two (Percentage of Total Inequality)**



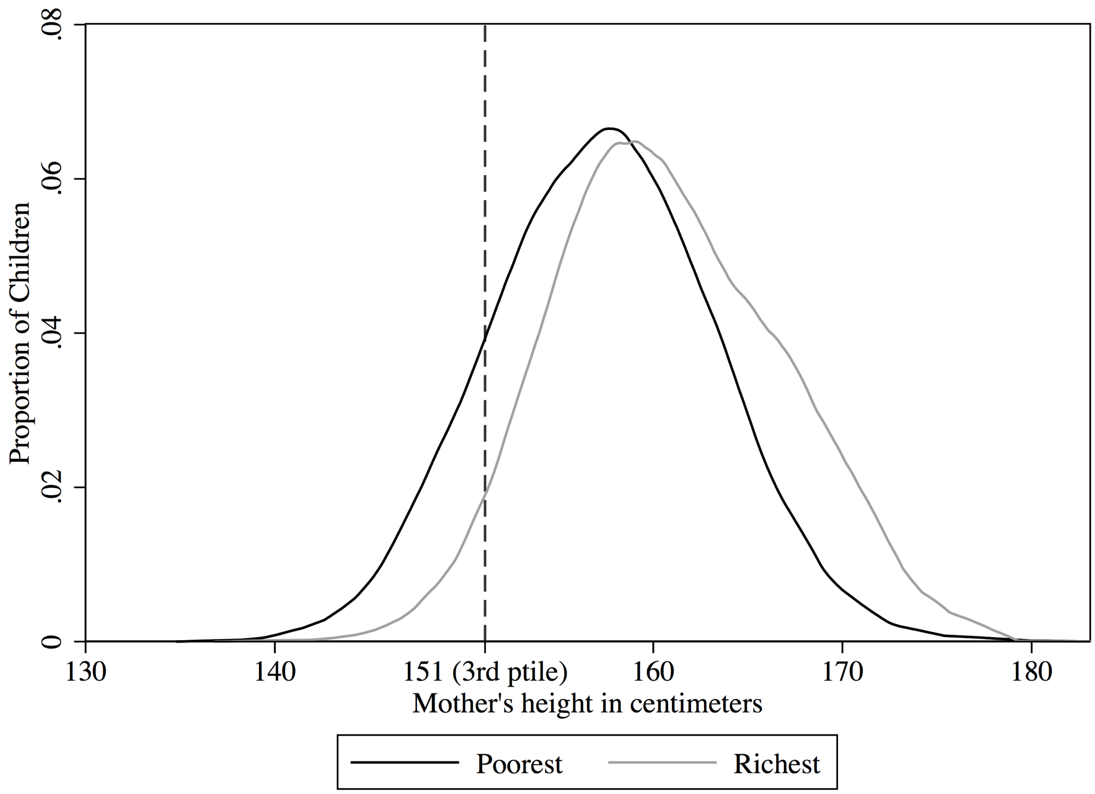
Source: Author’s calculations based on Jordan DHS 2012.

Figure 4.7. Distribution of Birth Weights (in Kilograms), Poorest and Richest Wealth Quintiles



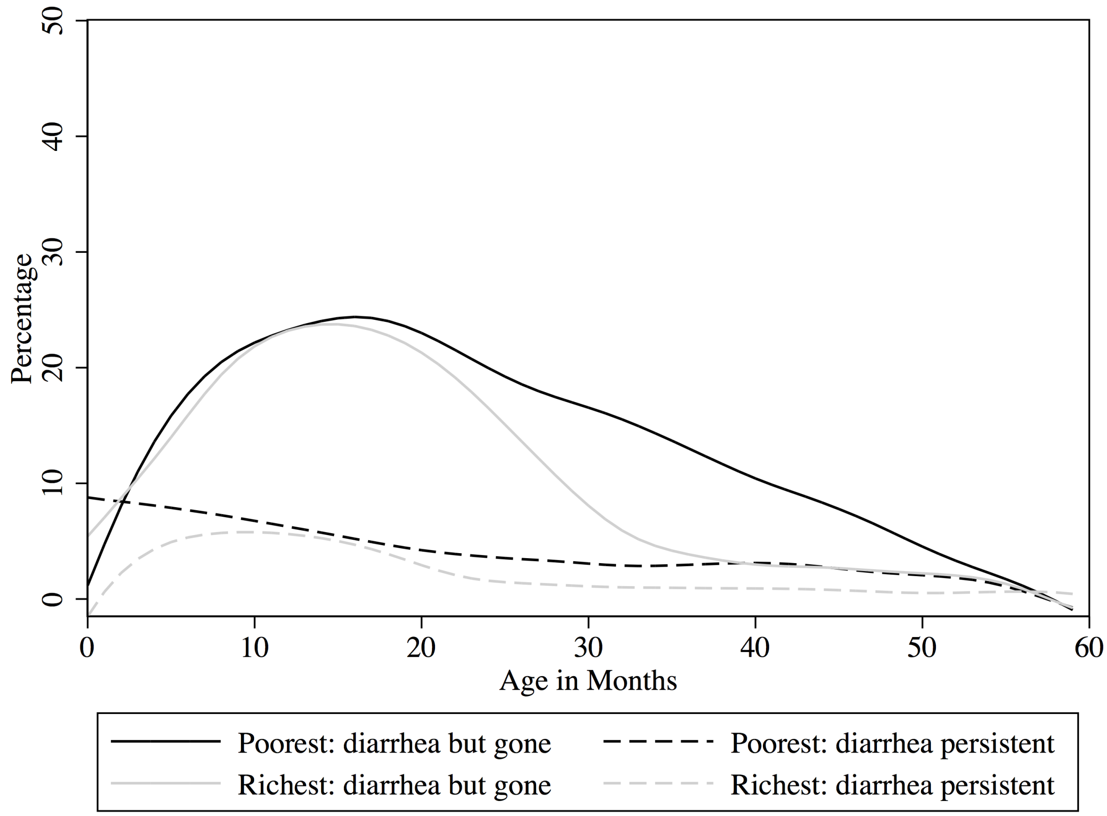
Source: Author's calculations based on Jordan DHS 2012.
Notes: Kernel densities, using Epanechnikov kernel (bandwidth 0.4).
Low birth weight defined as less than 2.5 kilograms.

Figure 4.8. Distribution of Mother's Height (in Centimeters), Poorest and Richest Wealth Quintiles



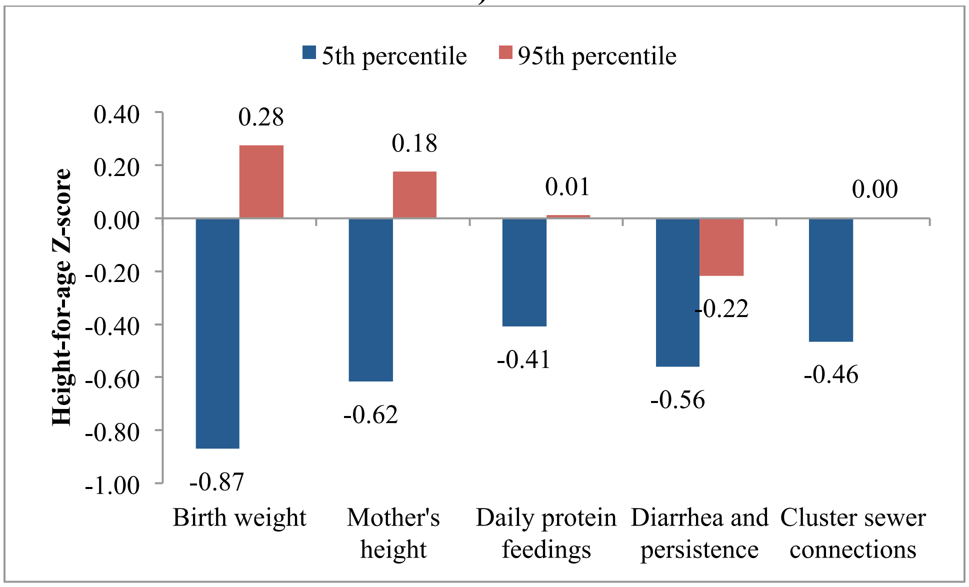
Source: Author's calculations based on Jordan DHS 2012.
Notes: Kernel densities, using Epanechnikov kernel (bandwidth 5).
Mother's height below 3rd percentile if less than 151.1112 centimeters per CDC growth charts for a 20-year-old female (Centers for Disease Control, 2001).

Figure 4.9. Diarrhea in the Past Two Weeks and Persistence by Age in Months (Percentages), Poorest and Richest Quintiles



Source: Author's calculations based on Jordan DHS 2012.
Notes: Lowess smoother (bandwidth 0.6).

Figure 4.10. Simulations of Height-for-age Z-scores (Shift from 5th to 95th Percentiles for Selected Covariates)



Source: Author's calculations based on Jordan DHS 2012.
Notes: Based on regressions for height-for-age, specification including prenatal environment and age in months (Table 4.4). All other characteristics as observed except the one being simulated.
Shifts from 5th to 95th percentiles are: birth weight of 2 kilograms to 4 kilograms, mother's height of 149.4 to 168.2, number of proteins from zero to four, diarrhea from persistent to none, cluster sewage connection from none to all.

Tables

Table 4.1. Categories of Variables

Category	Variables
Parents' education	Mother's education (6 categories), father's education (6 categories)
Wealth and employment	Household wealth factor (and square), mother's employment status (3 categories), father's employment status (4 categories), father's occupation (8 categories), mother's occupation (2 categories)
Gender	Female
Geography	Governorate (12 categories), rural, refugee camps, *badia* (arid areas)
Food	Breastfeeding initiation after birth (8 categories), currently breastfed, exclusively breastfed, fed with a bottle, frequency of feeding, number of liquids fed, number of grains fed, number of fruits/leafy vegetables fed, number of proteins fed
Health knowledge	Mother knows tuberculosis is curable, mother knows oral rehydration salts (ORS), factor for family planning knowledge
Health conditions	Diarrhea and persistence (3 categories), fever/cough and persistence (3 categories)
Health environment	Household level: Drinking water source (4 categories), sewage connection, distance to health facilities is a big problem, mother smokes cigarettes, mother smokes nargile (hookah), household members smoke, persons per room Cluster level: Share drinking water source (4 categories), share sewage connection, wealth of other households (and square)
Mother's demographics	Mother's age at birth (7 categories), mother's height (in centimeters), birth interval (in months), first birth
Birth weight	Birth weight (in kilograms) and indicator if missing
Age in months (not a circumstance)	Categorically

Table 4.2. Anthropometrics by Socio-economic Status, Youngest Child Under Two

	Height-for-age (z-score)	Weight-for-age (z-score)	Weight-for-height (z-score)	Stunted (percentage)	Under-weight (percentage)	Wasted (percentage)	Percentage of Sample
Father's education							
No education	-0.91	-0.28	0.32	19.6	2.3	0.0	1.0
Elementary	-0.45	-0.13	0.17	12.6	5.5	4.1	8.9
Preparatory	-0.45	-0.13	0.20	16.5	5.4	3.7	17.4
Secondary	-0.23	0.07	0.29	7.8	3.2	2.4	48.7
Diploma	-0.22	0.21	0.49	13.2	3.1	1.1	7.9
University and above	0.11	0.20	0.27	4.3	1.4	1.4	16.0
Mother's education							
No education	-0.55	-0.23	0.11	12.9	6.3	1.0	1.4
Elementary	-0.48	0.13	0.58	12.2	1.5	0.9	5.7
Preparatory	-0.61	-0.11	0.30	17.8	3.4	1.8	14.1
Secondary	-0.27	-0.03	0.19	9.8	5.2	3.6	46.2
Diploma	0.13	0.17	0.18	5.2	2.2	2.4	12.0
University and above	-0.03	0.24	0.43	5.8	0.8	1.1	20.7
Wealth quintile							
Poorest	-0.62	-0.24	0.20	16.7	5.0	4.2	23.6
Poorer	-0.26	0.02	0.24	9.8	3.9	4.7	22.7
Middle	-0.27	0.09	0.32	7.6	2.1	0.4	22.1
Richer	-0.03	0.22	0.34	10.2	5.2	1.6	17.5
Richest	0.24	0.27	0.28	0.7	0.2	0.3	14.0
Father's employment status							
Not present/not working	-0.34	0.01	0.30	14.1	1.8	2.7	9.9
Wage worker	-0.25	0.05	0.29	9.3	3.2	1.9	69.4
Employer	-0.07	0.05	0.15	10.7	7.3	4.3	8.8
Self-employed	-0.23	0.07	0.24	7.6	3.6	4.4	11.8
Mother's employment status							
Not working	-0.29	0.01	0.25	10.1	3.9	2.6	86.1
Wage worker	0.06	0.29	0.41	7.1	1.0	1.8	13.1
Other work	0.12	0.15	0.11	13.3	0.8	0.0	0.9
Father's occupation							
Did not work	-0.34	0.01	0.30	14.1	1.8	2.7	9.9
Professional/ technical/ managerial	-0.10	0.15	0.35	4.1	1.4	1.1	20.1

	Height-for-age (z-score)	Weight-for-age (z-score)	Weight-for-height (z-score)	Stunted (percent-age)	Under-weight (percent-age)	Wasted (percent-age)	Percent-age of Sample
Clerical	0.00	0.13	0.24	9.6	4.5	1.8	7.0
Sales	-0.23	0.12	0.35	11.7	2.7	2.7	11.4
Agricultural	-0.53	-0.27	0.05	5.2	3.0	1.0	1.6
Household and domestic	-0.77	-0.35	0.19	20.8	8.3	0.0	1.3
Services	-0.29	-0.01	0.24	10.1	3.5	1.5	15.9
Skilled manual	-0.27	0.01	0.24	10.6	5.5	3.9	29.7
Unskilled manual	-0.36	-0.10	0.11	12.6	1.9	4.8	3.1
Mother's occupation							
Not working	-0.29	0.01	0.25	10.1	3.9	2.6	86.1
Professional/ technical/ managerial	0.18	0.31	0.36	4.1	0.9	1.8	11.3
Other occupations	-0.42	0.18	0.52	22.2	1.0	1.1	2.6
Total	-0.24	0.04	0.27	9.7	3.5	2.5	100.0
N	2,230	2,230	2,230	2,230	2,230	2,230	2,230

Source: Author’s calculations based on Jordan DHS 2012.

Table 4.3. Summary Statistics for Covariates, Youngest Child Under Two

	Mean	Standard deviation
Wealth		
Wealth score	6.720	1.140
Wealth score sq./100	0.465	0.165
Father's education		
No education	0.010	0.099
Elementary	0.089	0.285
Preparatory	0.178	0.382
Secondary	0.483	0.500
Diploma	0.079	0.269
University and above	0.161	0.368
Mother's education		
No education	0.014	0.116
Elementary	0.058	0.234
Preparatory	0.137	0.344
Secondary	0.464	0.499
Diploma	0.121	0.327
University and above	0.205	0.404
Father's employment status		
Not present/not working	0.103	0.303
Wage worker	0.691	0.462
Employer	0.085	0.279
Self-employed	0.121	0.326
Mother's employment status		
Not working	0.864	0.342
Wage worker	0.127	0.333
Other work	0.009	0.092
Father's occupation		
Did not work	0.103	0.303
Professional/technical/managerial	0.204	0.403
Clerical	0.070	0.256
Sales	0.109	0.312
Agricultural	0.016	0.125
Household and domestic	0.014	0.117
Services	0.155	0.362
Skilled manual	0.296	0.457
Unskilled manual	0.033	0.179
Mother's occupation		
Not working	0.864	0.342
Professional/technical/managerial	0.111	0.315
Other occupations	0.024	0.154
Rural	0.209	0.407
Camps	0.043	0.202
Badia	0.083	0.276
Governorate of residence		
Amman	0.353	0.478
Balqa	0.074	0.262
Zarqa	0.138	0.345

	Mean	Standard deviation
Madaba	0.029	0.167
Irbid	0.184	0.388
Mafraq	0.060	0.238
Jarash	0.040	0.196
Ajlun	0.025	0.157
Karak	0.045	0.208
Tafiela	0.015	0.123
Ma'an	0.019	0.136
Aqaba	0.016	0.127
Female	0.447	0.497
Breastfeeding initiation		
Not breastfed	0.053	0.224
Immediately	0.129	0.336
Within first hour	0.065	0.247
One hour	0.176	0.381
2-24 hours	0.339	0.473
One day	0.121	0.326
Two days	0.056	0.229
3 or more days	0.061	0.240
Other liquids within 3 days birth	0.666	0.472
Exclusively breastfed	0.055	0.229
Currently breastfed	0.525	0.500
Drank from bottle	0.571	0.495
Feeding frequency		
None	0.207	0.405
Once	0.104	0.306
Twice	0.212	0.409
Three times	0.316	0.465
Four +	0.160	0.367
Number liquids	2.395	1.190
Number grains	1.278	1.007
Number proteins	1.696	1.483
Number fruits and vegs.	0.759	0.821
Diarrhea		
None	0.738	0.440
Yes but gone	0.194	0.395
Yes still	0.068	0.251
Fever/Cough		
None	0.657	0.475
Yes but gone	0.029	0.166
Yes still	0.314	0.464
Persons per room	1.792	0.929
Average cluster wealth factor	9.601	0.753
Average cluster wealth factor sq./100	0.927	0.151
Cluster share of households not flushing to sewer	0.498	0.461
Cluster water		
Cluster share of households with bottled water	0.404	0.216
Cluster share of households with water piped in and treated	0.210	0.148

	Mean	Standard deviation
Cluster share of households with water piped in and not treated	0.300	0.230
Cluster share of households with other water source	0.086	0.195
Household Water		
Bottled	0.430	0.495
Piped to dwelling treated	0.218	0.413
Piped to dwelling not treated	0.280	0.449
Other	0.072	0.258
Flush to latrine/other	0.487	0.500
Household members smoke	0.639	0.481
Mother smokes cigarettes	0.066	0.248
Mother smokes nargile	0.088	0.284
Distance to health care problematic	0.307	0.462
Know tuberculosis is curable	0.540	0.498
Know of oral rehydration salts	0.915	0.280
Exposure to family planning factor	0.033	0.793
Mother's age		
15-19	0.031	0.172
20-24	0.186	0.389
25-29	0.291	0.455
30-34	0.261	0.439
35-39	0.160	0.367
40-44	0.068	0.252
45-49	0.003	0.053
Mother's height (in centimeters)	158.563	5.965
Birth spacing (in months)	37.348	18.484
First birth	0.205	0.404
Birth weight in kilograms	3.118	0.609
Birth weight in kilograms missing	0.008	0.088
N (Observations)	2,111	

Source: Author's calculations based on Jordan DHS 2012.

Table 4.4. Regressions for Height-for-age (in Centimeters as a 24-month Female), Youngest Child Under Two

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Wealth						
Wealth score	2.850*	2.346*	0.941	0.717	1.225	0.930
	(1.110)	(1.146)	(1.097)	(1.131)	(1.052)	(1.079)
Wealth score sq./100	-15.492*	-11.396	-1.572	-0.230	-6.285	-4.510
	(7.476)	(7.886)	(7.446)	(7.721)	(7.116)	(7.415)
Father's education (none omit.)						
Elementary	0.748	0.895	0.578	0.574	0.617	0.836
	(1.187)	(1.164)	(1.106)	(1.029)	(1.061)	(0.968)
Preparatory	0.693	0.805	0.547	0.574	0.316	0.525
	(1.175)	(1.183)	(1.122)	(1.068)	(1.064)	(0.996)
Secondary	0.728	0.911	0.535	0.633	0.057	0.398
	(1.178)	(1.161)	(1.074)	(1.010)	(1.038)	(0.955)
Diploma	0.906	1.224	0.628	0.793	0.503	0.846
	(1.569)	(1.470)	(1.301)	(1.187)	(1.204)	(1.112)
University and above	1.844	2.076	1.839	1.862	1.241	1.500
	(1.318)	(1.290)	(1.179)	(1.110)	(1.136)	(1.051)
Mother's education (none omit.)						
Elementary	-0.534	-0.417	-1.285	-1.203	-2.248*	-2.058*
	(0.987)	(1.024)	(1.048)	(1.039)	(1.006)	(1.002)
Preparatory	-1.225	-1.113	-2.148*	-2.053*	-2.715**	-2.504**
	(0.990)	(1.031)	(1.035)	(1.030)	(0.971)	(0.967)
Secondary	-0.358	-0.388	-1.574	-1.679	-1.944*	-1.963*
	(0.905)	(0.940)	(0.967)	(0.963)	(0.919)	(0.915)
Diploma	0.550	0.531	-0.972	-1.078	-1.185	-1.302
	(0.998)	(1.016)	(1.077)	(1.074)	(1.018)	(1.011)
University and above	-0.445	-0.666	-1.845	-2.077*	-1.917	-2.122*
	(1.048)	(1.059)	(1.057)	(1.045)	(1.012)	(1.001)
Father's emp. status (none/absent omit.)						
Wage worker	-1.198	-1.196	-1.275*	-1.282*	-1.358*	-1.328*
	(0.708)	(0.635)	(0.604)	(0.558)	(0.580)	(0.539)
Employer	-1.024	-0.935	-1.158	-0.866	-1.305	-1.007
	(1.072)	(0.969)	(0.983)	(0.910)	(0.881)	(0.805)
Self-employed	-1.068	-1.025	-1.123	-1.087	-1.423*	-1.321*
	(0.873)	(0.814)	(0.783)	(0.746)	(0.698)	(0.672)
Mother's employment status (none omit.)						
Wage worker	0.298	0.368	0.392	0.419	0.537	0.542
	(0.545)	(0.535)	(0.506)	(0.482)	(0.488)	(0.467)
Other work	1.757	1.911	1.881	2.213	1.584	1.779
	(2.033)	(1.985)	(1.979)	(1.897)	(1.795)	(1.734)
Father's occup. (professional omit.)						

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Clerical	1.371	1.176	1.625*	1.358*	1.412	1.150*
	(0.946)	(0.754)	(0.811)	(0.630)	(0.719)	(0.578)
Sales	0.425	0.294	0.111	-0.031	-0.083	-0.173
	(0.706)	(0.670)	(0.694)	(0.697)	(0.605)	(0.612)
Agricultural	0.672	0.457	0.141	-0.250	0.404	0.037
	(0.852)	(0.788)	(0.790)	(0.767)	(0.776)	(0.735)
Household and domestic	-0.230	0.063	-0.282	-0.159	0.301	0.332
	(1.213)	(1.143)	(1.112)	(1.080)	(0.947)	(0.927)
Services	0.599	0.714	0.584	0.484	0.762	0.680
	(0.690)	(0.591)	(0.591)	(0.532)	(0.518)	(0.476)
Skilled manual	0.800	0.771	0.630	0.499	0.929	0.766
	(0.626)	(0.558)	(0.552)	(0.502)	(0.498)	(0.457)
Unskilled manual	1.191	1.334	0.703	0.829	1.023	1.170
	(1.017)	(0.946)	(0.965)	(0.968)	(0.853)	(0.866)
Mother's occup. (professional omit.)						
Other occupations	-0.611	-0.612	-0.555	-0.767	-0.631	-0.778
	(0.964)	(0.936)	(0.927)	(0.872)	(0.849)	(0.800)
Rural			-0.124	0.004	-0.030	0.038
			(0.342)	(0.324)	(0.329)	(0.315)
Area of residence						
Balqa			0.359	0.451	0.295	0.323
			(0.575)	(0.540)	(0.549)	(0.505)
Zarqa			-0.151	-0.229	-0.459	-0.579
			(0.582)	(0.540)	(0.549)	(0.508)
Madaba			0.485	0.650	0.352	0.400
			(0.515)	(0.489)	(0.503)	(0.475)
Irbid			0.069	0.077	-0.218	-0.277
			(0.565)	(0.552)	(0.538)	(0.522)
Mafraq			-0.986*	-0.960*	-0.905*	-0.913*
			(0.496)	(0.475)	(0.438)	(0.421)
Jarash			-0.879	-0.798	-0.813	-0.810
			(0.537)	(0.501)	(0.503)	(0.468)
Ajlun			-0.501	-0.472	-0.655	-0.673
			(0.573)	(0.582)	(0.519)	(0.529)
Karak			0.398	0.462	0.165	0.148
			(0.652)	(0.616)	(0.616)	(0.579)
Tafiela			-0.292	-0.191	-0.415	-0.412
			(0.627)	(0.604)	(0.598)	(0.577)
Ma'an			-1.245*	-1.263*	-0.981	-1.082*
			(0.544)	(0.495)	(0.501)	(0.459)
Aqaba			-0.979	-1.027	-0.968	-1.024
			(0.679)	(0.677)	(0.660)	(0.657)
Camps			-0.079	-0.130	-0.284	-0.251
			(0.499)	(0.473)	(0.475)	(0.448)

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Badia			0.236	0.325	0.505	0.576
			(0.520)	(0.506)	(0.449)	(0.432)
Female			0.195	0.147	0.679*	0.636*
			(0.293)	(0.277)	(0.278)	(0.264)
Breastfeeding init. (never omit.)						
Immediately			1.321	1.613	0.523	0.816
			(1.056)	(0.997)	(0.960)	(0.911)
Within first hour			0.558	0.931	-0.080	0.283
			(1.030)	(0.916)	(0.941)	(0.833)
One hour			1.295	1.599	0.361	0.701
			(1.028)	(0.926)	(0.910)	(0.834)
2-24 hours			1.369	1.617	0.445	0.699
			(0.948)	(0.855)	(0.856)	(0.783)
One day			1.313	1.486	0.566	0.730
			(1.021)	(0.931)	(0.941)	(0.869)
Two days			1.765	2.323*	1.092	1.596
			(1.092)	(0.995)	(1.011)	(0.937)
3 or more days			0.666	0.912	0.199	0.354
			(1.010)	(0.932)	(0.912)	(0.863)
Other liquids within 3 days birth			-0.838*	-0.775*	-0.585	-0.553
			(0.344)	(0.334)	(0.311)	(0.298)
Exclusively breastfed			2.010**	2.034**	1.470*	1.578*
			(0.703)	(0.762)	(0.570)	(0.625)
Currently breastfed			0.759*	-0.173	0.501	-0.374
			(0.325)	(0.350)	(0.304)	(0.339)
Drank from bottle			1.188***	0.793*	1.022***	0.676*
			(0.346)	(0.326)	(0.300)	(0.283)
Feeding frequency						
Once			0.797	0.759	0.689	0.561
			(0.603)	(0.648)	(0.624)	(0.665)
Twice			1.458*	1.514*	1.463**	1.361*
			(0.589)	(0.660)	(0.541)	(0.612)
Three times			1.042	1.244	0.922	0.987
			(0.574)	(0.662)	(0.523)	(0.616)
Four +			0.812	0.900	0.878	0.882
			(0.622)	(0.728)	(0.567)	(0.662)
No. Foods						
No. liquids			-0.119	-0.052	-0.121	-0.064
			(0.183)	(0.171)	(0.169)	(0.155)
No. grains			-0.090	0.025	-0.134	-0.038
			(0.192)	(0.181)	(0.177)	(0.167)
No. protein			0.226	0.392*	0.196	0.339*
			(0.175)	(0.173)	(0.151)	(0.150)
No. fruits and vegs.			-0.161	0.105	-0.102	0.129
			(0.238)	(0.216)	(0.184)	(0.181)

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Diarrhea (none omit.)						
Yes but gone			0.115	-0.094	0.285	0.160
			(0.436)	(0.385)	(0.384)	(0.334)
Yes still			-0.920*	-1.283**	-0.823	-1.109*
			(0.461)	(0.467)	(0.446)	(0.452)
Fever/Cough (none omit.)						
Yes but gone			-0.388	-0.341	-0.339	-0.263
			(0.822)	(0.749)	(0.828)	(0.751)
Yes still			0.286	0.288	0.381	0.359
			(0.327)	(0.315)	(0.307)	(0.296)
Persons per room			-0.042	-0.072	0.013	-0.073
			(0.168)	(0.194)	(0.171)	(0.186)
Cluster wealth						
Average cluster wealth factor			11.306***	10.058**	10.106***	8.394**
			(3.211)	(3.394)	(2.867)	(2.981)
Average cluster wealth factor sq./100			-58.532***	-52.197**	-51.319***	-42.639**
			(15.776)	(16.697)	(14.118)	(14.742)
Cluster share of households not flushing to sewer			-2.397	-2.365	-1.591	-1.508
			(1.343)	(1.215)	(1.272)	(1.144)
Cluster water (bottled omit.)						
Cluster share of households with water piped in and treated			-4.690**	-4.254**	-3.786**	-3.366*
			(1.546)	(1.431)	(1.383)	(1.304)
Cluster share of households with water piped in and not treated			-0.828	-0.869	-0.497	-0.546
			(0.907)	(0.922)	(0.824)	(0.841)
Cluster share of households with other water source			1.307	1.519	1.711	1.904*
			(1.003)	(1.075)	(0.906)	(0.937)
Household Sanitation (Sewer omit.)						
Flush to latrine/other			1.961	1.832	1.358	1.194
			(1.159)	(1.053)	(1.084)	(0.982)
Household Water (bottled omit.)						
Piped to dwelling treated			-0.049	-0.139	-0.018	-0.107
			(0.459)	(0.411)	(0.393)	(0.362)
Piped to dwelling not treated			-0.434	-0.350	-0.468	-0.453
			(0.360)	(0.350)	(0.327)	(0.315)
Other			-0.763	-0.862	-1.006	-1.137*
			(0.581)	(0.567)	(0.512)	(0.493)
Household members smoke			-0.177	-0.207	-0.064	-0.057
			(0.280)	(0.264)	(0.253)	(0.237)
Mother smokes cigarettes			-1.186	-0.764	-1.081*	-0.753
			(0.670)	(0.602)	(0.549)	(0.507)

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Mother smokes nargile			0.372	0.310	0.001	-0.061
			(0.422)	(0.429)	(0.397)	(0.398)
Know TB is curable			0.213	0.274	0.091	0.159
			(0.308)	(0.280)	(0.268)	(0.240)
Know of ORS			-0.078	-0.059	0.102	0.023
			(0.455)	(0.409)	(0.451)	(0.400)
Exposure to family planning			0.262	0.179	0.256	0.172
			(0.165)	(0.160)	(0.151)	(0.142)
Distance to health care problematic			-0.048	-0.019	0.005	0.055
			(0.300)	(0.279)	(0.296)	(0.265)
Mother's age (15-19 omit.)						
20-24					0.019	0.461
					(0.645)	(0.581)
25-29					-0.756	-0.074
					(0.608)	(0.571)
30-34					-0.435	0.319
					(0.663)	(0.614)
35-39					-0.584	0.056
					(0.697)	(0.695)
40-44					-0.921	-0.214
					(0.732)	(0.686)
45-49					-2.800*	-2.136
					(1.357)	(1.301)
Mother's height (in centimeters)					0.153***	0.136***
					(0.024)	(0.022)
Birth spacing (months)					0.022**	0.023**
					(0.008)	(0.007)
First birth					-0.147	-0.233
					(0.373)	(0.360)
Birth weight in kilograms					1.774***	1.848***
					(0.218)	(0.205)
Birth weight in kilograms missing					-4.967**	-4.630***
					(1.614)	(1.335)
Constant	72.982***	73.074***	25.783	30.996	1.593	11.461
	(3.854)	(4.001)	(16.243)	(17.077)	(15.465)	(15.645)
Age (months)	No	Yes	No	Yes	No	Yes
P-value (model)	0.000	0.000	0.000	0.000	0.000	0.000
N(Observations)	2111	2111	2111	2111	2111	2111
R-squared	0.064	0.127	0.175	0.231	0.289	0.337
Adj. R-squared	0.053	0.107	0.142	0.192	0.256	0.299

Source: Author's calculations based on Jordan DHS 2012.
Notes: *p<0.05; **p<0.01; ***p<0.001
Clustered standard errors in parentheses.

Table 4.5. Regressions for Weight-for-age (in Kilograms as a 24-month Female), Youngest Child Under Two

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Wealth						
Wealth score	1.181**	0.884*	0.706	0.522	0.768	0.554
	(0.402)	(0.383)	(0.446)	(0.437)	(0.476)	(0.463)
Wealth score sq./100	-7.125**	-4.907	-3.399	-2.148	-4.467	-2.989
	(2.721)	(2.672)	(3.074)	(3.061)	(3.374)	(3.309)
Father's education (none omit.)						
Elementary	0.037	0.120	-0.150	-0.092	-0.085	0.028
	(0.362)	(0.332)	(0.302)	(0.273)	(0.300)	(0.289)
Preparatory	0.085	0.135	-0.138	-0.089	-0.128	-0.024
	(0.354)	(0.326)	(0.287)	(0.259)	(0.289)	(0.282)
Secondary	0.151	0.233	-0.067	-0.009	-0.144	-0.023
	(0.348)	(0.317)	(0.283)	(0.256)	(0.290)	(0.281)
Diploma	0.383	0.428	0.034	0.073	0.075	0.176
	(0.463)	(0.408)	(0.368)	(0.330)	(0.344)	(0.333)
University and above	0.255	0.300	0.047	0.063	-0.067	0.012
	(0.402)	(0.373)	(0.342)	(0.316)	(0.338)	(0.331)
Mother's education (none omit.)						
Elementary	0.213	0.216	-0.023	-0.007	-0.250	-0.238
	(0.309)	(0.308)	(0.289)	(0.290)	(0.287)	(0.280)
Preparatory	-0.329	-0.321	-0.501	-0.501	-0.592*	-0.586*
	(0.301)	(0.295)	(0.300)	(0.297)	(0.292)	(0.283)
Secondary	-0.167	-0.166	-0.390	-0.409	-0.483	-0.499
	(0.285)	(0.277)	(0.289)	(0.286)	(0.284)	(0.276)
Diploma	0.080	0.070	-0.225	-0.243	-0.280	-0.311
	(0.316)	(0.307)	(0.325)	(0.323)	(0.313)	(0.306)
University and above	0.096	0.046	-0.194	-0.245	-0.286	-0.363
	(0.340)	(0.322)	(0.314)	(0.310)	(0.309)	(0.302)
Father's emp. status (none/absent omit.)						
Wage worker	-0.395	-0.360	-0.308	-0.266	-0.412*	-0.368
	(0.224)	(0.216)	(0.202)	(0.199)	(0.197)	(0.195)
Employer	-0.362	-0.355	-0.294	-0.240	-0.453	-0.413
	(0.349)	(0.319)	(0.323)	(0.300)	(0.305)	(0.280)
Self-employed	-0.407	-0.369	-0.328	-0.268	-0.501	-0.422
	(0.300)	(0.299)	(0.279)	(0.275)	(0.263)	(0.261)
Mother's employment status (none omit.)						
Wage worker	0.089	0.163	0.154	0.193	0.202	0.244
	(0.200)	(0.193)	(0.172)	(0.175)	(0.169)	(0.171)
Other work	0.080	0.227	0.215	0.372	0.192	0.339
	(0.453)	(0.496)	(0.481)	(0.510)	(0.421)	(0.457)
Father's occup. (professional omit.)						

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Clerical	0.280	0.227	0.232	0.179	0.208	0.155
	(0.274)	(0.256)	(0.230)	(0.224)	(0.198)	(0.198)
Sales	0.354	0.249	0.241	0.133	0.274	0.176
	(0.286)	(0.266)	(0.267)	(0.262)	(0.243)	(0.241)
Agricultural	0.048	0.091	-0.225	-0.223	-0.037	-0.015
	(0.334)	(0.318)	(0.324)	(0.309)	(0.312)	(0.294)
Household and domestic	-0.088	-0.051	-0.239	-0.226	-0.053	-0.044
	(0.341)	(0.318)	(0.340)	(0.326)	(0.319)	(0.313)
Services	0.196	0.253	0.075	0.100	0.215	0.233
	(0.282)	(0.258)	(0.248)	(0.230)	(0.219)	(0.207)
Skilled manual	0.272	0.256	0.179	0.150	0.302	0.261
	(0.221)	(0.204)	(0.188)	(0.184)	(0.175)	(0.175)
Unskilled manual	0.261	0.291	0.133	0.157	0.259	0.270
	(0.311)	(0.286)	(0.266)	(0.245)	(0.243)	(0.229)
Mother's occup. (professional omit.)						
Other occupations	0.220	0.153	0.178	0.113	0.109	0.062
	(0.352)	(0.360)	(0.364)	(0.364)	(0.338)	(0.342)
Rural			-0.019	-0.005	0.002	0.003
			(0.114)	(0.113)	(0.111)	(0.111)
Area of residence						
Balqa			0.236	0.238	0.202	0.194
			(0.191)	(0.183)	(0.180)	(0.170)
Zarqa			0.077	0.061	-0.015	-0.034
			(0.190)	(0.179)	(0.180)	(0.169)
Madaba			0.227	0.239	0.170	0.158
			(0.185)	(0.181)	(0.178)	(0.172)
Irbid			0.037	0.031	-0.058	-0.100
			(0.191)	(0.191)	(0.185)	(0.184)
Mafraq			0.081	0.087	0.123	0.122
			(0.159)	(0.159)	(0.152)	(0.152)
Jarash			0.032	0.037	0.057	0.038
			(0.212)	(0.202)	(0.205)	(0.198)
Ajlun			0.301	0.313	0.253	0.258
			(0.223)	(0.219)	(0.217)	(0.213)
Karak			0.320	0.349	0.224	0.246
			(0.212)	(0.200)	(0.210)	(0.201)
Tafiela			0.246	0.270	0.218	0.228
			(0.256)	(0.249)	(0.245)	(0.238)
Ma'an			-0.312	-0.304	-0.262	-0.252
			(0.208)	(0.194)	(0.180)	(0.167)
Aqaba			0.286	0.238	0.299	0.234
			(0.240)	(0.236)	(0.251)	(0.242)
Camps			0.050	0.011	0.003	-0.017
			(0.171)	(0.165)	(0.165)	(0.159)

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Badia			-0.070	-0.080	-0.005	-0.024
			(0.173)	(0.171)	(0.158)	(0.155)
Female			-0.011	-0.004	0.158	0.166
			(0.105)	(0.099)	(0.101)	(0.097)
Breastfeeding init. (never omit.)						
Immediately			-0.211	-0.182	-0.547	-0.521
			(0.417)	(0.406)	(0.394)	(0.382)
Within first hour			-0.432	-0.346	-0.632	-0.558
			(0.408)	(0.379)	(0.381)	(0.358)
One hour			-0.173	-0.142	-0.514	-0.479
			(0.399)	(0.378)	(0.381)	(0.363)
2-24 hours			-0.169	-0.178	-0.520	-0.527
			(0.388)	(0.367)	(0.373)	(0.356)
One day			0.027	0.029	-0.335	-0.331
			(0.402)	(0.384)	(0.381)	(0.368)
Two days			0.029	0.062	-0.299	-0.293
			(0.405)	(0.386)	(0.390)	(0.375)
3 or more days			-0.421	-0.384	-0.586	-0.571
			(0.386)	(0.371)	(0.368)	(0.355)
Other liquids within 3 days birth			-0.254	-0.230	-0.136	-0.128
			(0.131)	(0.127)	(0.115)	(0.113)
Exclusively breastfed			0.883***	0.702**	0.735**	0.579**
			(0.247)	(0.246)	(0.223)	(0.209)
Currently breastfed			0.255*	0.116	0.191	0.072
			(0.124)	(0.130)	(0.115)	(0.121)
Drank from bottle			0.295*	0.223*	0.235*	0.171
			(0.121)	(0.113)	(0.113)	(0.107)
Feeding frequency						
Once			-0.057	-0.061	-0.079	-0.084
			(0.199)	(0.223)	(0.179)	(0.201)
Twice			0.148	0.062	0.194	0.091
			(0.230)	(0.244)	(0.200)	(0.220)
Three times			-0.125	-0.224	-0.159	-0.267
			(0.260)	(0.272)	(0.231)	(0.247)
Four +			-0.248	-0.323	-0.179	-0.258
			(0.258)	(0.282)	(0.225)	(0.253)
No. Foods						
No. liquids			0.023	0.041	0.021	0.037
			(0.067)	(0.063)	(0.063)	(0.059)
No. grains			-0.016	-0.004	-0.039	-0.032
			(0.065)	(0.064)	(0.062)	(0.059)
No. protein			0.152*	0.162*	0.129*	0.130*
			(0.064)	(0.064)	(0.059)	(0.058)
No. fruits and vegs.			0.032	0.045	0.061	0.067
			(0.074)	(0.077)	(0.068)	(0.073)

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Diarrhea (none omit.)						
Yes but gone			0.028	-0.051	0.080	0.017
			(0.157)	(0.142)	(0.151)	(0.136)
Yes still			-0.370*	-0.476**	-0.322*	-0.417*
			(0.163)	(0.163)	(0.161)	(0.163)
Fever/Cough (none omit.)						
Yes but gone			-0.005	-0.036	0.079	0.075
			(0.295)	(0.296)	(0.277)	(0.284)
Yes still			0.091	0.119	0.105	0.134
			(0.123)	(0.117)	(0.120)	(0.115)
Persons per room			0.036	0.009	0.018	-0.014
			(0.058)	(0.058)	(0.055)	(0.055)
Cluster wealth						
Average cluster wealth factor			3.813**	3.311*	3.350**	2.809*
			(1.316)	(1.318)	(1.297)	(1.293)
Average cluster wealth factor sq./100			-19.580**	-17.068**	-16.989**	-14.251*
			(6.479)	(6.512)	(6.454)	(6.486)
Cluster share of households not flushing to sewer			-0.584	-0.506	-0.202	-0.122
			(0.376)	(0.358)	(0.348)	(0.329)
Cluster water (bottled omit.)						
Cluster share of households with water piped in and treated			-0.748	-0.701	-0.455	-0.437
			(0.536)	(0.509)	(0.505)	(0.484)
Cluster share of households with water piped in and not treated			-0.194	-0.155	-0.146	-0.091
			(0.356)	(0.351)	(0.338)	(0.326)
Cluster share of households with other water source			0.354	0.492	0.381	0.532
			(0.391)	(0.377)	(0.370)	(0.354)
Household Sanitation (Sewer omit.)						
Flush to latrine/other			0.854**	0.717*	0.528	0.395
			(0.311)	(0.302)	(0.286)	(0.277)
Household Water (bottled omit.)						
Piped to dwelling treated			-0.008	0.030	0.019	0.054
			(0.144)	(0.145)	(0.139)	(0.141)
Piped to dwelling not treated			-0.148	-0.121	-0.175	-0.164
			(0.125)	(0.120)	(0.118)	(0.116)
Other			-0.213	-0.239	-0.282	-0.324
			(0.235)	(0.225)	(0.212)	(0.207)
Household members smoke			-0.006	-0.026	0.028	0.014
			(0.097)	(0.098)	(0.090)	(0.090)
Mother smokes cigarettes			-0.108	-0.038	-0.108	-0.041
			(0.254)	(0.232)	(0.230)	(0.212)

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Mother smokes nargile			-0.001	-0.003	-0.074	-0.074
			(0.213)	(0.211)	(0.208)	(0.207)
Know TB is curable			0.019	0.049	-0.032	0.004
			(0.105)	(0.100)	(0.098)	(0.092)
Know of ORS			-0.303	-0.271	-0.302*	-0.260
			(0.155)	(0.147)	(0.153)	(0.145)
Exposure to family planning			0.082	0.067	0.080	0.062
			(0.063)	(0.066)	(0.059)	(0.059)
Distance to health care problematic			-0.043	-0.052	-0.036	-0.046
			(0.115)	(0.110)	(0.109)	(0.103)
Mother's age (15-19 omit.)						
20-24					0.121	0.058
					(0.239)	(0.239)
25-29					0.299	0.300
					(0.240)	(0.245)
30-34					0.085	0.093
					(0.265)	(0.265)
35-39					0.292	0.251
					(0.277)	(0.280)
40-44					0.179	0.118
					(0.288)	(0.297)
45-49					-0.969	-0.968
					(0.499)	(0.593)
Mother's height (in centimeters)					0.031***	0.027**
					(0.009)	(0.008)
Birth spacing (months)					0.002	0.001
					(0.003)	(0.003)
First birth					0.096	0.120
					(0.150)	(0.147)
Birth weight in kilograms					0.759***	0.774***
					(0.078)	(0.074)
Birth weight in kilograms missing					-1.127*	-1.150*
					(0.539)	(0.471)
Constant	7.116***	7.712***	-9.426	-6.559	-14.387*	-10.611
	(1.340)	(1.299)	(6.389)	(6.363)	(6.218)	(6.156)
Age (months)	No	Yes	No	Yes	No	Yes
P-value (model)	0.001	0.000	0.000	0.000	0.000	0.000
N(Observations)	2111	2111	2111	2111	2111	2111
R-squared	0.046	0.093	0.143	0.176	0.242	0.271
Adj. R-squared	0.034	0.072	0.109	0.134	0.207	0.230

Source: Author’s calculations based on Jordan DHS 2012.
Notes: *p<0.05; **p<0.01; ***p<0.001
Clustered standard errors in parentheses.

Table 4.6. Regressions for Weight-for-height (in Kilograms as a 24-month Female), Youngest Child Under Two

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Wealth						
Wealth score	0.345	0.180	0.413	0.271	0.406	0.253
	(0.388)	(0.378)	(0.420)	(0.414)	(0.429)	(0.422)
Wealth score sq./100	-2.266	-1.080	-2.403	-1.419	-2.300	-1.212
	(2.746)	(2.710)	(2.979)	(2.949)	(3.066)	(3.024)
Father's education (none omit.)						
Elementary	-0.170	-0.131	-0.299	-0.238	-0.247	-0.187
	(0.257)	(0.256)	(0.218)	(0.214)	(0.200)	(0.200)
Preparatory	-0.084	-0.089	-0.262	-0.224	-0.199	-0.149
	(0.249)	(0.249)	(0.207)	(0.204)	(0.195)	(0.196)
Secondary	-0.020	-0.006	-0.186	-0.159	-0.142	-0.112
	(0.249)	(0.252)	(0.206)	(0.205)	(0.198)	(0.201)
Diploma	0.094	0.060	-0.154	-0.159	-0.080	-0.068
	(0.306)	(0.305)	(0.248)	(0.247)	(0.228)	(0.232)
University and above	-0.195	-0.218	-0.396	-0.389	-0.354	-0.342
	(0.290)	(0.293)	(0.247)	(0.245)	(0.232)	(0.235)
Mother's education (none omit.)						
Elementary	0.444	0.429	0.445	0.432	0.451	0.413
	(0.283)	(0.278)	(0.251)	(0.249)	(0.248)	(0.245)
Preparatory	-0.012	-0.012	0.076	0.051	0.119	0.074
	(0.234)	(0.229)	(0.232)	(0.230)	(0.232)	(0.231)
Secondary	-0.066	-0.074	0.014	0.002	0.014	-0.014
	(0.226)	(0.218)	(0.227)	(0.226)	(0.225)	(0.224)
Diploma	-0.004	-0.007	0.079	0.069	0.071	0.052
	(0.244)	(0.237)	(0.249)	(0.248)	(0.243)	(0.242)
University and above	0.279	0.263	0.322	0.306	0.262	0.215
	(0.254)	(0.244)	(0.247)	(0.243)	(0.248)	(0.247)
Father's emp. status (none/absent omit.)						
Wage worker	-0.071	-0.037	0.021	0.069	-0.054	-0.014
	(0.170)	(0.173)	(0.156)	(0.158)	(0.151)	(0.152)
Employer	-0.119	-0.132	-0.032	-0.030	-0.141	-0.155
	(0.229)	(0.240)	(0.209)	(0.222)	(0.211)	(0.219)
Self-employed	-0.158	-0.102	-0.047	0.032	-0.138	-0.055
	(0.213)	(0.218)	(0.197)	(0.197)	(0.191)	(0.190)
Mother's employment status (none omit.)						
Wage worker	-0.003	0.045	-0.003	0.030	0.007	0.046
	(0.190)	(0.178)	(0.188)	(0.178)	(0.182)	(0.175)
Other work	-0.365	-0.248	-0.250	-0.168	-0.195	-0.094
	(0.247)	(0.238)	(0.283)	(0.253)	(0.279)	(0.261)
Father's occup. (professional omit.)						

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Clerical	-0.065	-0.071	-0.162	-0.162	-0.137	-0.139
	(0.254)	(0.222)	(0.221)	(0.204)	(0.206)	(0.186)
Sales	0.184	0.097	0.154	0.066	0.228	0.136
	(0.214)	(0.213)	(0.203)	(0.205)	(0.198)	(0.199)
Agricultural	-0.197	-0.108	-0.353	-0.267	-0.236	-0.136
	(0.243)	(0.236)	(0.237)	(0.227)	(0.241)	(0.234)
Household and domestic	-0.036	-0.088	-0.228	-0.239	-0.195	-0.191
	(0.313)	(0.319)	(0.335)	(0.331)	(0.326)	(0.328)
Services	-0.038	-0.004	-0.159	-0.106	-0.075	-0.031
	(0.165)	(0.158)	(0.161)	(0.153)	(0.147)	(0.140)
Skilled manual	0.019	0.006	-0.025	-0.028	0.026	0.018
	(0.142)	(0.144)	(0.137)	(0.143)	(0.133)	(0.138)
Unskilled manual	-0.127	-0.112	-0.133	-0.125	-0.099	-0.110
	(0.226)	(0.250)	(0.217)	(0.251)	(0.218)	(0.245)
Mother's occup. (professional omit.)						
Other occupations	0.307	0.248	0.257	0.232	0.214	0.195
	(0.272)	(0.280)	(0.274)	(0.272)	(0.258)	(0.261)
Rural			-0.016	-0.030	-0.015	-0.028
			(0.097)	(0.094)	(0.095)	(0.092)
Area of residence						
Balqa			0.167	0.153	0.150	0.143
			(0.150)	(0.145)	(0.149)	(0.145)
Zarqa			0.111	0.115	0.101	0.111
			(0.130)	(0.128)	(0.128)	(0.128)
Madaba			0.080	0.042	0.067	0.033
			(0.152)	(0.152)	(0.150)	(0.148)
Irbid			0.058	0.049	0.042	0.016
			(0.161)	(0.159)	(0.159)	(0.155)
Mafraq			0.346**	0.344**	0.384**	0.383**
			(0.121)	(0.118)	(0.125)	(0.122)
Jarash			0.262	0.250	0.278	0.262
			(0.158)	(0.150)	(0.157)	(0.149)
Ajlun			0.468**	0.469**	0.468**	0.474**
			(0.165)	(0.162)	(0.167)	(0.164)
Karak			0.272	0.285	0.244	0.269
			(0.191)	(0.179)	(0.191)	(0.180)
Tafiela			0.326	0.333	0.338	0.356
			(0.217)	(0.213)	(0.216)	(0.211)
Ma'an			0.014	0.028	0.002	0.038
			(0.174)	(0.166)	(0.168)	(0.158)
Aqaba			0.484*	0.456*	0.509*	0.468*
			(0.204)	(0.195)	(0.207)	(0.194)
Camps			0.082	0.042	0.085	0.047
			(0.146)	(0.135)	(0.142)	(0.133)

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Badia			-0.143	-0.171	-0.145	-0.179
			(0.126)	(0.121)	(0.128)	(0.124)
Female			-0.029	-0.011	0.017	0.036
			(0.082)	(0.079)	(0.081)	(0.079)
Breastfeeding init. (never omit.)						
Immediately			-0.430	-0.472*	-0.560*	-0.604*
			(0.239)	(0.230)	(0.245)	(0.236)
Within first hour			-0.414	-0.414	-0.450	-0.457
			(0.251)	(0.239)	(0.249)	(0.241)
One hour			-0.372	-0.406	-0.476*	-0.512*
			(0.231)	(0.224)	(0.238)	(0.229)
2-24 hours			-0.369	-0.433*	-0.483*	-0.544*
			(0.212)	(0.208)	(0.219)	(0.216)
One day			-0.119	-0.160	-0.282	-0.318
			(0.226)	(0.215)	(0.216)	(0.210)
Two days			-0.250	-0.337	-0.399	-0.497*
			(0.272)	(0.247)	(0.260)	(0.241)
3 or more days			-0.503	-0.501*	-0.551*	-0.544*
			(0.268)	(0.252)	(0.263)	(0.250)
Other liquids within 3 days birth			0.015	0.016	0.064	0.057
			(0.100)	(0.096)	(0.095)	(0.091)
Exclusively breastfed			0.364	0.148	0.343	0.131
			(0.265)	(0.258)	(0.259)	(0.248)
Currently breastfed			0.148	0.185	0.152	0.196*
			(0.099)	(0.099)	(0.092)	(0.095)
Drank from bottle			0.070	0.078	0.049	0.054
			(0.087)	(0.086)	(0.086)	(0.085)
Feeding frequency						
Once			-0.401*	-0.351	-0.387*	-0.318
			(0.196)	(0.214)	(0.191)	(0.206)
Twice			-0.366	-0.415	-0.330	-0.361
			(0.200)	(0.224)	(0.193)	(0.217)
Three times			-0.555*	-0.645**	-0.559**	-0.630**
			(0.222)	(0.241)	(0.210)	(0.229)
Four +			-0.594**	-0.639**	-0.551**	-0.583*
			(0.212)	(0.237)	(0.200)	(0.227)
No. Foods						
No. liquids			0.061	0.064	0.061	0.062
			(0.048)	(0.045)	(0.046)	(0.043)
No. grains			-0.003	-0.013	-0.015	-0.025
			(0.052)	(0.048)	(0.050)	(0.046)
No. protein			0.093*	0.075*	0.078*	0.057
			(0.037)	(0.036)	(0.035)	(0.035)
No. fruits and vegs.			0.038	0.004	0.051	0.016
			(0.065)	(0.062)	(0.064)	(0.061)

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Diarrhea (none omit.)						
Yes but gone			-0.007	-0.036	-0.003	-0.035
			(0.089)	(0.085)	(0.092)	(0.088)
Yes still			-0.197	-0.224	-0.174	-0.208
			(0.134)	(0.127)	(0.131)	(0.124)
Fever/Cough (none omit.)						
Yes but gone			0.005	-0.048	0.070	0.034
			(0.225)	(0.226)	(0.203)	(0.208)
Yes still			0.000	0.024	-0.002	0.028
			(0.095)	(0.091)	(0.097)	(0.091)
Persons per room			0.030	0.006	0.001	-0.015
			(0.045)	(0.046)	(0.048)	(0.051)
Cluster wealth						
Average cluster wealth factor			0.658	0.375	0.507	0.298
			(1.316)	(1.291)	(1.306)	(1.319)
Average cluster wealth factor sq./100			-3.369	-1.967	-2.644	-1.592
			(6.609)	(6.530)	(6.580)	(6.708)
Cluster share of households not flushing to sewer			0.088	0.157	0.240	0.303
			(0.241)	(0.240)	(0.238)	(0.240)
Cluster water (bottled omit.)						
Cluster share of households with water piped in and treated			0.426	0.382	0.511	0.446
			(0.362)	(0.369)	(0.359)	(0.363)
Cluster share of households with water piped in and not treated			-0.050	-0.020	-0.074	-0.028
			(0.307)	(0.300)	(0.300)	(0.287)
Cluster share of households with other water source			-0.100	0.015	-0.159	-0.030
			(0.419)	(0.407)	(0.403)	(0.386)
Household Sanitation (Sewer omit.)						
Flush to latrine/other			0.350	0.235	0.195	0.089
			(0.194)	(0.194)	(0.194)	(0.199)
Household Water (bottled omit.)						
Piped to dwelling treated			-0.053	0.004	-0.034	0.020
			(0.127)	(0.122)	(0.127)	(0.124)
Piped to dwelling not treated			-0.015	-0.003	-0.038	-0.026
			(0.122)	(0.114)	(0.118)	(0.110)
Other			-0.023	-0.034	-0.030	-0.049
			(0.239)	(0.221)	(0.234)	(0.215)
Household members smoke			0.039	0.023	0.045	0.024
			(0.087)	(0.085)	(0.083)	(0.080)
Mother smokes cigarettes			0.182	0.170	0.171	0.176
			(0.180)	(0.179)	(0.186)	(0.181)

	SES	SES and age/birth month	+ Early env.	+ Early env. and age/birth month	+ Prenatal env.	+ Prenatal env. and age/birth month
Mother smokes nargile			-0.084	-0.086	-0.065	-0.065
			(0.182)	(0.172)	(0.179)	(0.170)
Know TB is curable			-0.041	-0.025	-0.069	-0.050
			(0.095)	(0.091)	(0.094)	(0.090)
Know of ORS			-0.300*	-0.260	-0.334*	-0.264*
			(0.136)	(0.137)	(0.132)	(0.131)
Exposure to family planning			0.020	0.023	0.019	0.019
			(0.051)	(0.050)	(0.048)	(0.048)
Distance to health care problematic			-0.031	-0.043	-0.034	-0.051
			(0.091)	(0.084)	(0.088)	(0.082)
Mother's age (15-19 omit.)						
20-24					0.101	-0.046
					(0.201)	(0.216)
25-29					0.402*	0.257
					(0.203)	(0.220)
30-34					0.133	-0.019
					(0.216)	(0.229)
35-39					0.369	0.194
					(0.219)	(0.234)
40-44					0.453	0.247
					(0.251)	(0.269)
45-49					-0.185	-0.354
					(0.343)	(0.440)
Mother's height (in centimeters)					-0.007	-0.007
					(0.008)	(0.007)
Birth spacing (months)					-0.004	-0.005*
					(0.002)	(0.002)
First birth					0.133	0.171
					(0.137)	(0.135)
Birth weight in kilograms					0.292***	0.290***
					(0.076)	(0.073)
Birth weight in kilograms missing					-0.044	-0.140
					(0.336)	(0.336)
Constant	10.697***	11.114***	7.312	9.244	8.268	10.091
	(1.265)	(1.263)	(5.928)	(5.943)	(6.208)	(6.338)
Age (months)	No	Yes	No	Yes	No	Yes
P-value (model)	0.320	0.007	0.000	0.000	0.000	0.000
N(Observations)	2111	2111	2111	2111	2111	2111
R-squared	0.023	0.077	0.097	0.138	0.127	0.168
Adj. R-squared	0.011	0.056	0.061	0.094	0.087	0.120

Source: Author’s calculations based on Jordan DHS 2012.
Notes: *p<0.05; **p<0.01; ***p<0.001
Clustered standard errors in parentheses.

Table 4.7. Inequality and Inequality of Opportunity in Child Anthropometry, Youngest Child Under Two

Outcome: / Specification:	Height-for-age / SES	Weight-for-age / SES	Weight-for-height / SES	Height-for-age / + Early env.	Weight-for-age / + Early env.	Weight-for-height / + Early env.	Height-for-age / + Prenatal env.	Weight-for-age / + Prenatal env.	Weight-for-height / + Prenatal env.
Total inequality	0.00133***	0.00865***	0.00541***	0.00133***	0.00865***	0.00541***	0.00133***	0.00865***	0.00541***
	(0.0000799)	(0.000536)	(0.000292)	(0.0000834)	(0.000527)	(0.000289)	(0.0000800)	(0.000552)	(0.000281)
Residual inequality	0.00124***	0.00828***	0.00529***	0.00115***	0.00754***	0.00501***	0.000987***	0.00667***	0.00486***
	(0.0000770)	(0.000529)	(0.000284)	(0.0000793)	(0.000474)	(0.000279)	(0.0000638)	(0.000433)	(0.000265)
Inequality of opportunity (share of total inequality)	0.0641**	0.0427**	0.0209	0.136***	0.129***	0.0733**	0.258***	0.229***	0.101***
	(0.0207)	(0.0162)	(0.0120)	(0.0306)	(0.0239)	(0.0241)	(0.0283)	(0.0251)	(0.0273)
Inequality of op. partial effects (share of total Inequality)									
Parent's education	0.0300*	0.0188	0.0151	0.0180	0.0131	0.0139	0.0191	0.00883	0.0123
	(0.0131)	(0.0117)	(0.00950)	(0.0133)	(0.0131)	(0.0105)	(0.0129)	(0.0121)	(0.0116)
Wealth and employment	0.0456*	0.0307*	0.00634	0.0423*	0.0320	0.00328	0.0196	0.0246	0.00326
	(0.0214)	(0.0155)	(0.00992)	(0.0205)	(0.0163)	(0.0131)	(0.0246)	(0.0161)	(0.0135)
Gender				0.000571	-0.0000316	0.0000325	-0.00157	-0.00175	-0.000383
				(0.00303)	(0.00222)	(0.00194)	(0.00473)	(0.00345)	(0.00201)
Area of residence				0.00670	0.00596	0.00773	0.000595	0.00315	0.00821
				(0.0109)	(0.00879)	(0.00814)	(0.0116)	(0.00802)	(0.00788)

Outcome: Specification:	Height-for-age SES	Weight-for-age SES	Weight-for-height SES	Height-for-age + Early env.	Weight-for-age + Early env.	Weight-for-height + Early env.	Height-for-age + Prenatal env.	Weight-for-age + Prenatal env.	Weight-for-height + Prenatal env.
Food				0.0140	0.0413*	0.0189	0.0118	0.0338	0.0145
				(0.0227)	(0.0161)	(0.0213)	(0.0194)	(0.0178)	(0.0219)
Health knowledge				0.00748	0.00396	0.00365	0.00694	0.00302	0.00338
				(0.00748)	(0.00555)	(0.00476)	(0.00694)	(0.00552)	(0.00505)
Health conditions				0.00328	0.00349	0.00154	0.00457	0.00372	0.00139
				(0.00621)	(0.00609)	(0.00438)	(0.00621)	(0.00548)	(0.00469)
Health environment				0.0513*	0.0238	0.0131	0.0537*	0.0277	0.0133
				(0.0242)	(0.0194)	(0.0148)	(0.0219)	(0.0171)	(0.0136)
Mother's demographics							0.0741***	0.0207	0.00783
							(0.0176)	(0.0124)	(0.0107)
Birth weight							0.112***	0.120***	0.0157
							(0.0231)	(0.0207)	(0.00925)
N	2111	2111	2111	2111	2111	2111	2111	2111	2111

Source: Author’s calculations based on Jordan DHS 2012.
Notes: *p<0.05; **p<0.01; ***p<0.001
Clustered bootstrapped standard errors in parentheses.

Chapter 5

5 Conclusions

The human development of individuals, especially their health, skills, education, and labor market participation, crucially shapes opportunities and outcomes throughout their lives. Individuals weigh a number of different factors when making decisions about human development. For instance, in considering whether to go to school or drop out and get an apprenticeship, young people and their families must consider the likely costs and benefits of each of their options. As this dissertation has demonstrated, these options are defined and constrained by the context in which individuals live, historical factors, and current policies. For example, in Egypt, the option of vocational secondary education has become substantially devalued as public sector employment opportunities have declined and formal, well-paid private sector jobs have remained scarce. Thus, human development is constrained by limited economic development and the policies and history of the education system. At the same time, human development is also a driver of economic development (Sala-i-Martin, Doppelhofer, & Miller, 2004; Sen, 1999; Suri, Boozer, Ranis, & Stewart, 2011). The intertwined relationship between economic and human development makes understanding their interlinked complexities, such as why socio-economic status affects children's nutrition, critically important.

The MENA region in particular faces a number of unique human and economic development challenges (Chaaban, 2009; Salehi-Isfahani, 2013; United Nations Development Programme Regional Bureau for Arab States, 2009; World Bank, 2012). Education levels have risen rapidly, but without the expected benefits of education, leading to a disconnect that has contributed to uprisings and turmoil in the region (Campante & Chor, 2012). Gender inequality is a major problem in the region, particularly in regards to women's ability to participate in the labor market (World Bank, 2013a, 2013c). Sharp disparities and unequal opportunities for human development arise early in life and shape the lifecourse (El-Kogali & Krafft, 2015; Krafft & El-Kogali, 2014). This dissertation has investigated some of the causes and consequences of these human development challenges in MENA in order to provide insight into how to promote both human and economic development in the region.

In the first essay, the assumption that formal secondary schooling is the best route to job skills was tested in Egypt. Specifically, the returns to a vocational secondary education were compared to alternative routes to skills acquisition, such as undertaking an apprenticeship to become a craftsman. The essay demonstrated that for recent generations, the returns to a vocational secondary education were the same as obtaining no formal degree, that is, zero. In contrast, skills acquired elsewhere, particularly becoming an apprentice and ultimately a craftsman, had substantial returns, even for youth. These results held even after addressing endogeneity using within-family estimation (comparing siblings with family fixed effects).

The findings of the first essay provide a number of important insights for education research and policy. The literature on the returns to schooling is large enough for meta-analyses (Psacharopoulos & Patrinos, 2004), as is the literature on how to improve learning and school performance in developing countries (Glewwe, Hanushek, Humpage, & Ravina, 2013; Kremer, Brannen, & Glennerster, 2013; McEwan, 2014). The literature on other, non-school routes to acquiring job skills (including training and apprenticeships) is fragmentary and meager in comparison (Frazis & Loewenstein, 2005; Wolter & Ryan, 2011). Alternative routes to human capital other than formal schooling should be evaluated in other contexts to identify where, when, and potentially why different routes to human capital formation may be more or less valuable. One important reason that the returns to becoming a craftsman are more durable in Egypt than the returns to vocational secondary education may be the role of the market in the apprenticeship system. While vocational secondary education trains students essentially regardless of labor demand, craftsmen are very unlikely to take on apprentices without work for them to do. Thus, providing general skills in the education system and job skills directly through training in the labor market may be a better policy approach.

In the second essay, it was demonstrated that fertility has risen recently in Egypt. Whether declining employment opportunities for women, and therefore decreasing opportunity costs of childbearing, contributed to the recent rise in fertility was then investigated. Using discrete-time hazard models variously incorporating instrumental variables and fixed effects, the essay demonstrated that declining employment for women did increase their chances of childbearing. Although the magnitude of the resulting fertility simulations suggests that declining opportunities are unlikely to be the only factor contributing to the recent rise in fertility, this result demonstrates how economic forces can reverse the fertility transition. The findings are also a lesson in the unintended consequences of economic policies. Structural adjustment programs in Egypt, which reduced public sector employment opportunities, increased fertility.

Increasing public sector employment is not a viable policy solution to addressing the social and economic challenges posed by rising fertility. However, the fertility consequences of women's non-participation should be taken as yet another reason to work towards providing women with better labor market opportunities in the private sector in Egypt. Given their substantial domestic work burdens, private sector work and its longer hours are difficult to reconcile with family life for women (Assaad & Krafft, 2014, 2015c). Harassment and difficulties with childcare and transportation are also obstacles to women's participation in the labor market (Assaad & Arntz, 2005; Nassar, 2003; World Bank, 2013c). Addressing some of these obstacles, as well as encouraging alternative work-at-home or part-time private sector employment could help women reconcile work and family responsibilities (Krafft & Assaad, 2015). Additionally, although evidence demonstrates a rise in desired fertility, there remains unmet need for family planning that should be rapidly addressed in Egypt (Ministry of Health and Population, El-Zanaty and Associates, & ICF International, 2015). There is also a clear need for further research, especially qualitative research, on why families have increased their desired fertility. For instance, are additional children a hedge against old-age poverty as access to pensions has declined?

The third essay of the dissertation investigated the mediators of child health disparities in Jordan. Jordan is notable as the one country in the MENA region where at least the best-off have healthy growth (El-Kogali & Krafft, 2015). Yet the poorest children have growth that resembles the typical growth-faltering profile in low-income countries (Shrimpton, Victora, de Onis, et al., 2001; Victora, de Onis, Hallal, Blössner, & Shrimpton, 2010). The findings demonstrated that, as well as substantial disparities in child health not related to socio-economic disparities, prenatal factors (especially birth weight and mother's height) drive inequalities. Although the health environment and feeding practices also contribute to inequality, the results show a disproportionate role of development before children are even born.

The current landscape of nutrition policy is at odds with the findings of prenatal factors being disproportionately important. Policies and programs tend to emphasize the post-natal environment, including breastfeeding, the introduction of solid foods, health knowledge, and behaviors such as hand-washing (Bhutta, Ahmed, Black, et al., 2008; Black, Victora, Walker, et al., 2013; Horton, Shekar, McDonald, Mahal, & Brooks, 2010; World Bank, 2006, 2010). The results of the third essay suggest that these issues, at least in Jordan, are of secondary importance. Policies and programs should shift towards targeting pregnant mothers, prenatal growth, and birth weights, areas where there is a clear need for further research on costs, benefits, and optimal program design (Horton, Shekar, McDonald, Mahal, & Brooks, 2010; World Bank, 2006), especially in contrast to the post-natal literature.

While the essays in this dissertation provide important insight into specific human development issues in the MENA region, the findings share some common characteristics that merit broader consideration within development economics. Foremost is the importance of identifying and questioning assumptions, such as that school is the best route to skills or that nutrition policies should target children once they start to eat. The essays also demonstrate the importance of understanding the institutions and policies that are the context for individuals' and households' decision-making. Understanding rising fertility or falling returns to education in Egypt requires knowledge of the long history of a multitude of economic and social forces. The contradictory findings of the literature on what works in education in developing countries (Glewwe, Hanushek, Humpage, & Ravina, 2013; Kremer, Brannen, & Glennerster, 2013; McEwan, 2014) are an example of how context matters and how programs' and policies' impacts can vary widely. The essays also point to a number of important avenues for future research, such as evaluating nutrition policies targeting pregnancy and prenatal development. Although the goal of these essays is to contribute to the literature on the microeconomics of development in the Middle East and North Africa, this contribution will be valuable only if it is built on by future work.

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